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ATARS/ATC SIMULATION TESTS WITH SITE-ADAPTATION LOGIC.(U)

JAN 79 J R WINDLE, G MORFITT, P J DEVINE

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ATARS/ATC SIMULATION TESTS WITH SITE-ADAPTATION LOGIC

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JANUARY 1979

FINAL REPORT

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16. Abstract

The objective of this project was to assess the effectiveness of proposed Automatic Traffic Advisory and Resolution Service (ATARS) site-adapted logic designed to reduce unnecessary alarms in a terminal air traffic control environment. The tests were conducted at the National Aviation Facilities Experimental Center (NAFEC) at Atlantic City, New Jersey, using the Air Traffic Control Simulation Facility (ATCSF). Test results indicated that the site-adapted logic reduced the numerous unnecessary alarms experienced in previous simulation tests. In fact, no ATARS alarms were generated in any of the tests involving instrument flight rules (IFR) separation procedures. Under IFR and/visual flight rules (VFR) separation rules, a total of seven ATARS controller alerts was issued over four 1-hour data runs. One aircraft received a positive vertical command, and four received negative horizontal commands; the remaining aircraft received flashing proximity warning indicators (FPWI's). The majority of the eight controllers participating in these tests favored ATARS use and indicated that ATARS with site-adapted logic did not impact control procedures. Recommendations are made for further improvements in ATARS desensitization in the terminal ATC area, for additional studies to improve tracker performance and ATARS performance under reduced VFR ATC separation criteria, and for additional tests to evaluate ATARS performance in a terminal environment with uncontrolled aircraft flying in proximity to controlled aircraft.

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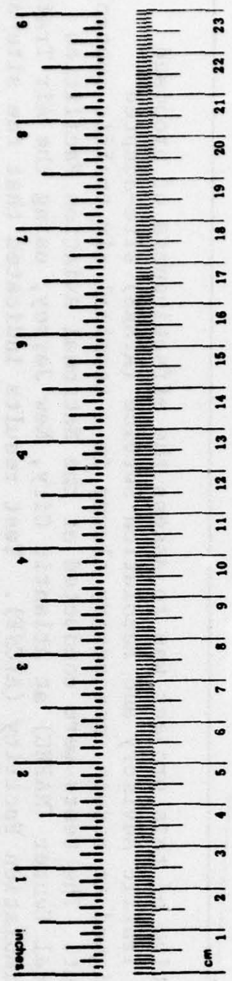
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

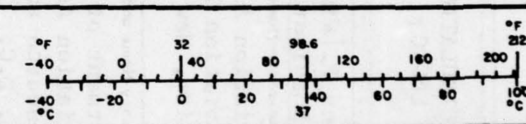


TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

INTRODUCTION

PURPOSE.

The objective of these tests was to assess the effectiveness of proposed Automatic Traffic Advisory and Resolution Service (ATARS) site-adaptation logic designed to reduce unnecessary alarms in a high-density terminal air traffic control (ATC) environment.

BACKGROUND.

In 1975, the National Aviation Facilities Experimental Center (NAFEC) conducted dynamic simulation tests to investigate the operational and procedural problems that might exist when Intermittent Positive Control (IPC) was introduced into a terminal ATC environment. The results of those tests were reported in reference 1. In general, the results indicated that an excessive number of unnecessary alarms were being generated in the terminal area. The high alarm rate was considered intolerable by the controllers participating in the simulation.

In addition, the MITRE Corporation analyzed 11 hours of Automated Radar Terminal System (ARTS III) traffic data collected from four different terminals to quantify the alarm rates generated by the same IPC logic tested at NAFEC. MITRE tests also concluded that there were too many unnecessary alarms. It was suggested that a concerted effort be undertaken to eliminate false alarms while maintaining the necessary margin of safety. The program to accomplish this was called "IPC Site Adaptation." The IPC was later renamed ATARS.

Based on Monte Carlo type simulations and tests using ARTS III traffic data, three site-adapted logics were found to be effective in terms of reducing false alarms and maintaining safety. The first was to reduce alarm thresholds for controller alert, Flashing Proximity Warning Indicator (FPWI), and commands relative to those thresholds initially tested in the 1975 NAFEC simulations. The second was to incorporate a uniform logic which applied the same thresholds uniformly throughout the terminal area for both instrument flight rules (IFR) and visual flight rules (VFR) aircraft. The third was to further refine the final approach desensitization logic used in the 1975 NAFEC tests so that ATARS commands would not be issued to aircraft already established on the instrument landing system (ILS) course. These three changes were introduced into the ATARS algorithm for testing at NAFEC, and the report herein presents the results of testing.

DISCUSSION

TEST ENVIRONMENT.

The testing used the Air Traffic Control Simulation Facility (ATCSF) at NAFEC in a stand-alone configuration. The test environment simulated a single Discrete Address Beacon System (DABS) sensor site serving a terminal ATC facility. Testing was accomplished utilizing the ATARS algorithm provided by MITRE Corporation (reference 2) with new site-adaptation logic incorporated (reference 3). The simulated ATC facility consisted of six ATC control positions; one local control, one departure control, two arrival control, and two enroute feeder control positions. The terminal environment was the same as that used in previous IPC/ATC testing at NAFEC. The terminal area included all traffic within a 30-nautical-mile (nmi) radius of the center of the airport. Typical traffic flows in the terminal area are shown in figure 1.

Three series of tests were conducted. Each series consisted of four 1-hour 15-minute simulation runs. The first 15 minutes of a run were used for traffic buildup, and the last hour as the data base. The three test series were:

1. High-density, all-arrival, simultaneous parallel approaches, IFR separation;

2. Medium-density, arrival-departure, IFR separation; and

3. Medium-density, arrival-departure, IFR/VFR separation.

All aircraft were under the control of an air traffic controller. In both of the IFR-separation series, 75 percent of the aircraft were DABS/mode C equipped, and the remaining 25 percent were Air Traffic Control Radar Beacon System with altitude transponder (ATCRBS/mode C) equipped. In the IFR/VFR separation series, the percentages were 60 and 40, respectively. Twelve percent of the 150 aircraft in the IFR/VFR series were VFR flights. The traffic samples used in the current tests were identical to those used in the previous IPC/ATC tests at NAFEC.

IFR separation criteria used by the controllers were 1,000-feet vertical or 3-nmi horizontal. ATC separations used under assumed VFR weather conditions were 500 feet or 1.0 nmi between IFR/VFR and VFR/VFR aircraft, and 1,000 feet or 3 nmi between IFR/IFR aircraft. The purpose was to simulate visual approach procedures. No consideration was given to variable types of separation used between heavy and light aircraft as a result of wake turbulence avoidance.

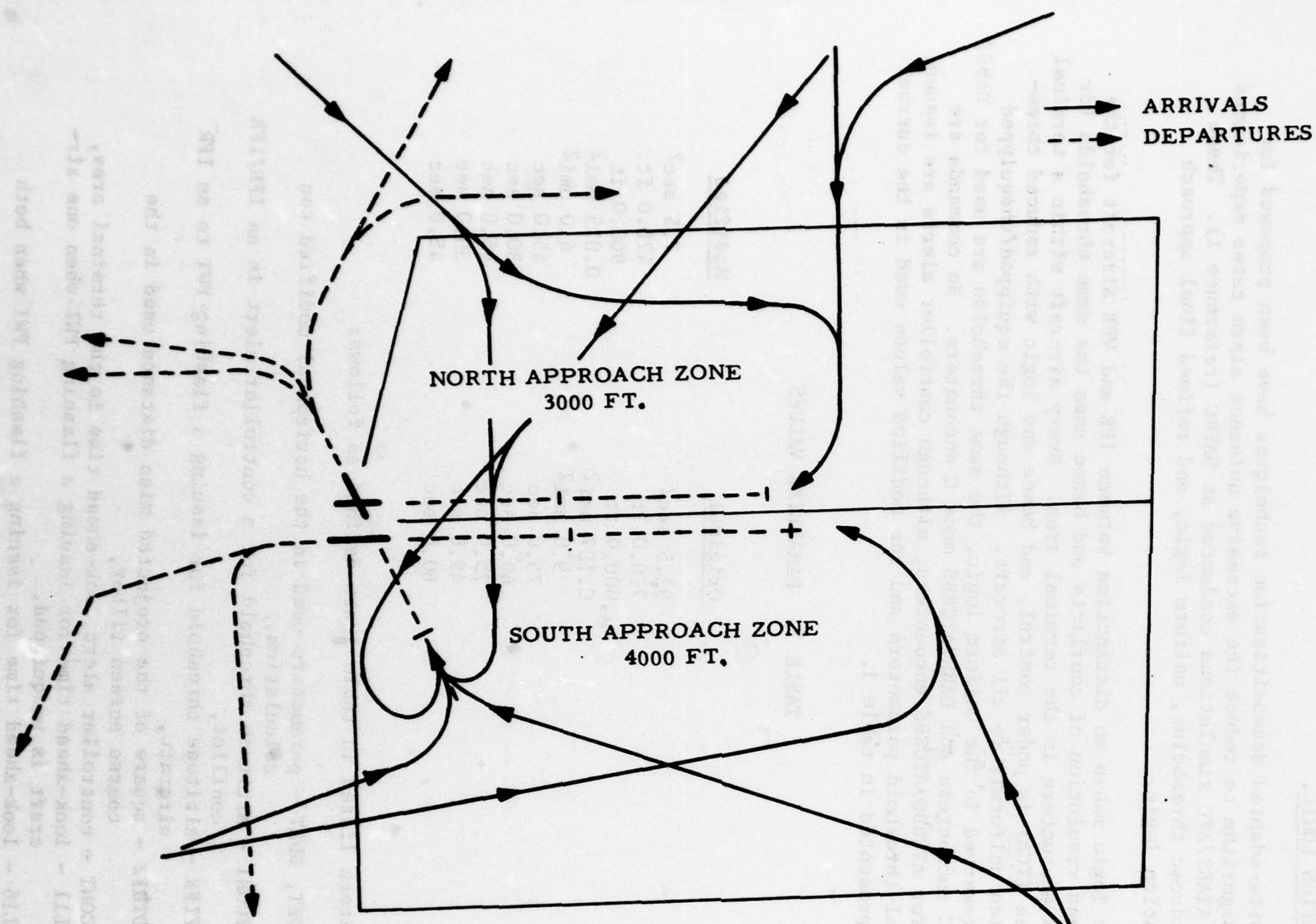


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FIGURE 1. TERMINAL AREA TRAFFIC FLOW

SITE-ADAPTATION LOGIC.

Three new site-adapted desensitization techniques have been proposed for the ATARS algorithm to reduce the excessive nuisance alarm rates experienced in earlier ATARS/ATC simulations conducted at NAFEC (reference 1). These included reduced thresholds, uniform logic, and refined final approach desensitization logic.

The uniform logic makes no distinction between IFR and VFR aircraft for the detection and resolution of conflicts and hence uses the same thresholds for IFR and VFR encounters in the terminal area. Every aircraft within a terminal control area (TCA) is under control, and hence one logic with reduced thresholds applies uniformly to all aircraft. Although the equipped/unequipped logic is preserved in the uniform logic, the same thresholds are used for DABS/DABS mode C encounters and DABS/ATCRBS mode C encounters. No commands are generated for ATCRBS/ATCRBS encounters, although controller alerts are issued. The original threshold parameters and the modified values used in the current tests are presented in table 1.

TABLE 1. PARAMETER VALUES

Parameter	Original	Modified
ADET	92.5 sec^2	7.5 sec^2
AFCONI	770.0 ft	470.0 ft
AFIFR	1,000.0 ft	900.0 ft
BDET	0.107 nmi^2	0.025 nmi^2
MDTHF2	9.0 nmi^2	4.0 nmi^2
TCONT	75.0 sec	45.0 sec
TL6	60.0 sec	30.0 sec
TL11	75.0 sec	45.0 sec
TL15	49.0 sec	30.0 sec
TL16	60.0 sec	45.0 sec

The parameters listed in table 1 are defined as follows:

ADET, BDET - parameters used in the horizontal modified tau calculation,
AFCONI - altitude threshold for a controller alert in an IFR/IFR conflict,
AFIFR - altitude threshold for issuing a flashing PWI to an IFR aircraft,
MDTHF2 - square of the projected miss distance used in the coarse screen filter,
TCONT - controller alert look-ahead time in the terminal area,
TL11 - look-ahead time for issuing a flashing PWI when one aircraft is unequipped,
TL16 - look-ahead time for issuing a flashing PWI when both aircraft are equipped,

TL6 - look-ahead time for issuing an ATARS command when one aircraft is unequipped, and

TL15 - look-ahead time for issuing an ATARS command when both aircraft are equipped.

With the exception of one modification, the ATARS desensitized areas (see figure 2) used in these tests were identical to the ones used in the previous NAFEC tests. In the previous tests, commands were not issued to an aircraft inside the desensitization zone when in conflict with another aircraft also inside the zone. An aircraft inside the zone was issued commands if in conflict with an aircraft outside the zone. In the current tests, commands were not issued to any aircraft inside the zone regardless of where the intruder was relative to the zone. Proximity Warning Indicator (PWI) service would still be provided to aircraft on final approach.

TEST RESULTS

IFR SEPARATION SERIES.

ATARS with the site-adaptation logic did not generate any controller alerts, FPWI, or commands during eight 1-hour data runs in either the all-arrival IFR separation series or the arrival/departure IFR separation series. Furthermore, a run-by-run analysis indicated no instances of unsafe encounters between aircraft wherein ATARS should have alarmed. Table 2 shows hourly operations rates for each run for both IFR separation series.

TABLE 2. HOURLY OPERATIONS RATES, IFR SERIES

Run	All Arrival	Arrival/Departure
1	86	79
2	86	79
3	84	81
4	79	81
AVERAGE	84	80

IFR/VFR SEPARATION SERIES.

In the arrival/departure IFR/VFR separation series, a total of seven ATARS encounters occurred involving 14 aircraft over four 1-hour data runs. Table 3 lists, for each run, the pairs of aircraft involved in each encounter, whether the aircraft were arrival or departure flights, flight status, equipment status, and the duration of ATARS alarms. All aircraft were mode C equipped. Detailed descriptions and track plots of each encounter pair are presented in the appendix. Encounter numbering in table 3 corresponds to the numbering on the plots in the appendix, and these numbers will be used to reference encounters throughout this report. As noted at the bottom of table 3, runs were not conducted in the exact order indicated in the table.

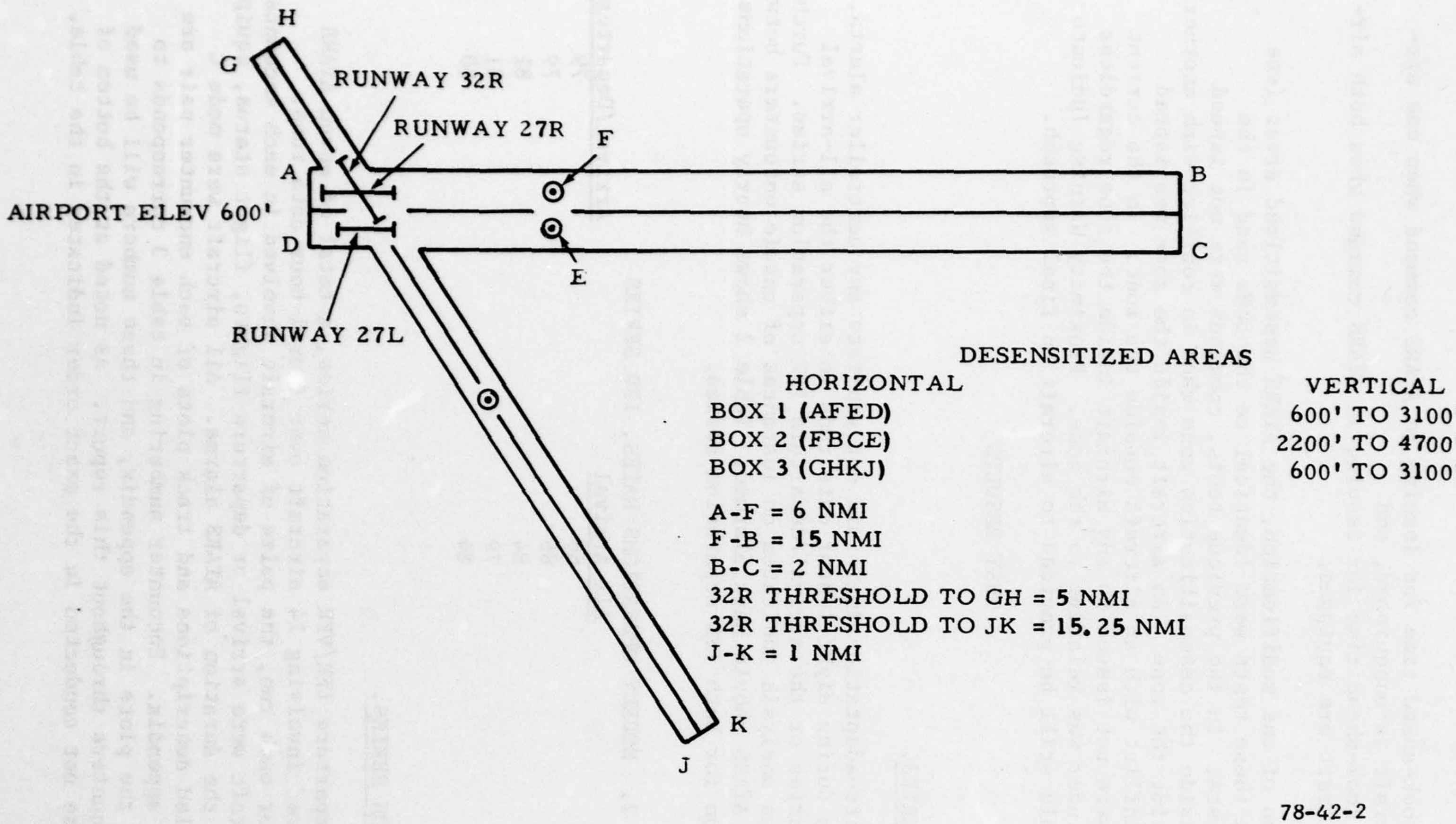

FIGURE 2. DESENSITIZED ATARS AREA USED IN NAFEC SIMULATION FOR CONTROLLED AIRCRAFT

TABLE 3. ARRIVAL/DEPARTURE IFR/VFR SERIES

Run* No.	Encounter Number	Aircraft Ident	ARR/ DEP	Flight Status	Equip D-DABS A-ATCRBS	NO. OF 4-SECOND SCANS** Total Encounter Duration	CA	FPWI	NEG CMD	POS CMD
1	1	NW604/PA318	ARR/ARR	IFR/IFR	D/D	4	3	4	0	0
	2	AA317/CO128	ARR/ARR	IFR/IFR	D/D	2	1	2	0	0
	3	AA241/AA887	ARR/DEP	IFR/IFR	D/D	5	4	1	4	0
2	4	A30924/N5303	ARR/DEP	IFR/VFR	A/A	4	4	0	0	0
	5	AA241/N5316	ARR/DEP	IFR/VFR	D/A	11	10	5	1	5
	6	A30454/TW97	ARR/ARR	IFR/IFR	A/D	4	3	1	3	0
3	7	OZ967/N5164W	ARR/ARR	IFR/VFR	D/A	9	8	6	3	0
4		NO ATARS ALARMS								

*For convenience, runs are tabulated 1 through 4; however, runs were conducted in random order in simulation.

**Tabulated data read as follows:

For example, encounter 5; total duration 11 scans consisting of 5 scans FPWI alone, plus 1 scan of a negative command, accompanied by FPWI, plus 5 scans of a positive command, accompanied by FPWI. The controller was alerted for 10 of these 11 scans.

Two of the runs involved three encounters each, another run involved one encounter, and a fourth run had none. The average was 1.8 encounters per hour.

Only one positive command, a climb of 20-seconds duration, was issued during all four runs. The climb was issued in encounter number 5, in which a positive command was required to safely resolve the conflict. This encounter involved a DABS/mode C equipped arrival aircraft descending from 10,000 feet to 6,000 feet altitude and an ATCRBS/mode C equipped departure aircraft level at 7,000 feet. The ATARS issued a climb command to the arrival aircraft and satisfactorily resolved an unsafe situation. A more detailed description of this encounter is contained in the appendix.

There were three encounters in which aircraft received negative commands. These were encounters number 3, 6, and 7 (see table 3). Encounter 3 involved an arrival/departure DABS/mode C equipped pair of aircraft. The departure aircraft was cleared to pass over the arrival. ATARS issued negative right turns to both aircraft, and the aircraft passed 1.7 nmi of each other when at coaltitude. Encounter number 6 involved an arrival/arrival pair of aircraft, one of which was DABS/mode C equipped and the other ATCRBS/mode C equipped. The DABS-equipped aircraft failed to intercept the ILS approach course on the controller's initial clearance, crossed through the parallel ILS courses, and was being vectored for another approach (see encounter 6 in appendix). ATARS issued a negative right-turn command, and the aircraft approached each other no closer than 1.37 nmi horizontally and 115 feet vertically. Encounter 7 involved an arrival/arrival pair of aircraft, one of which was DABS/mode C and the other ATCRBS/mode C equipped. ATARS issued a negative right-turn command, and the closest point of approach between the aircraft was 0.91 nmi horizontally and 425 feet vertically. In all of these three encounters, the negative commands did not interfere with the intent of the controller. The commands were advisory in nature and did not impact the controller adversely or cause an aircraft to deviate from its flightpath.

Four of the seven encounters occurred between arrival/arrival pairs, and the remaining three encounters between arrival/departure pairs. With one exception, arrival/arrival encounters occurred between opposite-side arrivals being vectored to final approach to the parallel ILS courses. As can be seen in figure 3, opposite-side arrival encounters 1, 2, and 6 occurred 23 to 28 nmi east of the runways, which is 3 to 8 nmi beyond the east edge of the desensitized zone. Extending the desensitized zone to 28 nmi would not have affected the outcome in any of the three encounters. Even though in encounters 1 and 2 one of the aircraft would have been in the desensitized zone, no commands were involved. Encounter 6 occurred laterally outside an extended desensitized zone and would not be affected. A desensitized zone could have been developed to include encounter number 6; however, this would have increased the size of the zone, and the intent was to minimize the desensitization area.

The fourth encounter involving an arrival pair, encounter 7 in figure 3, occurred about 8 nmi northeast of the airport. This is the downwind area for runway 27R, where small aircraft are transiting the area to get to the final approach for runway 32R.

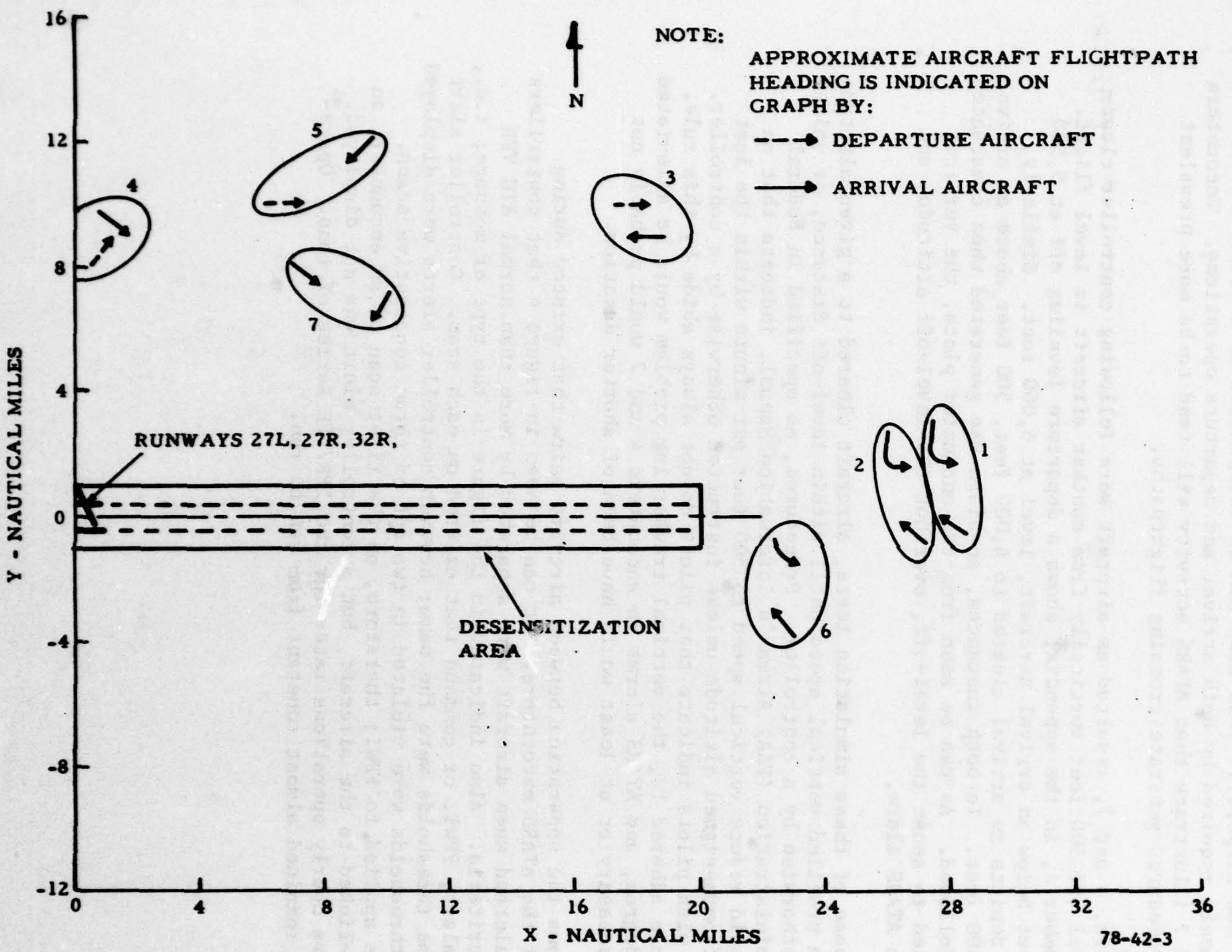

FIGURE 3. LOCATION OF ENCOUNTERS, ARRIVAL/DEPARTURE IFR/VFR SERIES

The three encounters involving arrival/departure pairs occurred as departures were being passed over or under arrivals as shown in figure 3 (8 to 12 nmi northeast of the airport). This area can be categorized as a transition environment commonly required by both arrival and departure operations. Encounters 3, 4, 5, and 7 illustrate that ATARS activity will tend to be more prevalent where ATC procedures generate crossing flightpaths.

Two encounters, 4 and 7, resulted as aircraft were following controller clearances to level off 500 feet vertically from another aircraft in level flight. Encounter number 4, in the appendix, shows a departure leveling off at 5,500 feet, 500 feet below an arrival aircraft, level at 6,000 feet. Similarly, encounter 7 depicts an arrival cleared to 4,000 feet, 500 feet above an arrival level at 3,500 feet. In both instances, an alarm was generated when clearances were being followed. As can be seen from the encounter plots, the vertical tracker failed to sense the level-off, overshot the level-off altitude, and triggered an ATARS alarm.

For the purpose of these simulation tests, aircraft cleared to a given altitude maintained a profiled vertical speed until within level-off distance, or unless instructed otherwise by a controller. Procedures, as specified in Federal Aviation Administration (FAA) Airman's Information Manual, indicate that an aircraft should reduce vertical speed to 500 feet per minute within the last 1,000 feet from assigned altitude unless instructed otherwise by a controller. Discussions with pilots indicate that pilots do not always abide by this rule. Were this rule adhered to, the vertical tracker lag problem would be alleviated to a great degree, and ATARS alarms in encounters 4 and 7 would probably not have been necessary or at least would have been of shorter duration.

Figure 4 shows the separation between aircraft pairs that existed during each scan of the ATARS encounters. It can be seen in figure 4 that controllers were being alerted when aircraft were separated by more than normal ATC VFR separation criteria. Also indicated in the figure is the type of message; i.e., controller alert, FPWI, or command that existed on each scan. Controller alert and FPWI time thresholds were the same; however controller alerts were displayed only after thresholds were violated in two out of three consecutive scans. No such rule applied to FPWI; therefore, on the first scan of an encounter, an FPWI was up-linked to the aircraft, but a controller alert was not displayed. Table 4 shows hourly operations rates for the IFR/VFR series of runs. Operations rates remained almost constant from run to run.

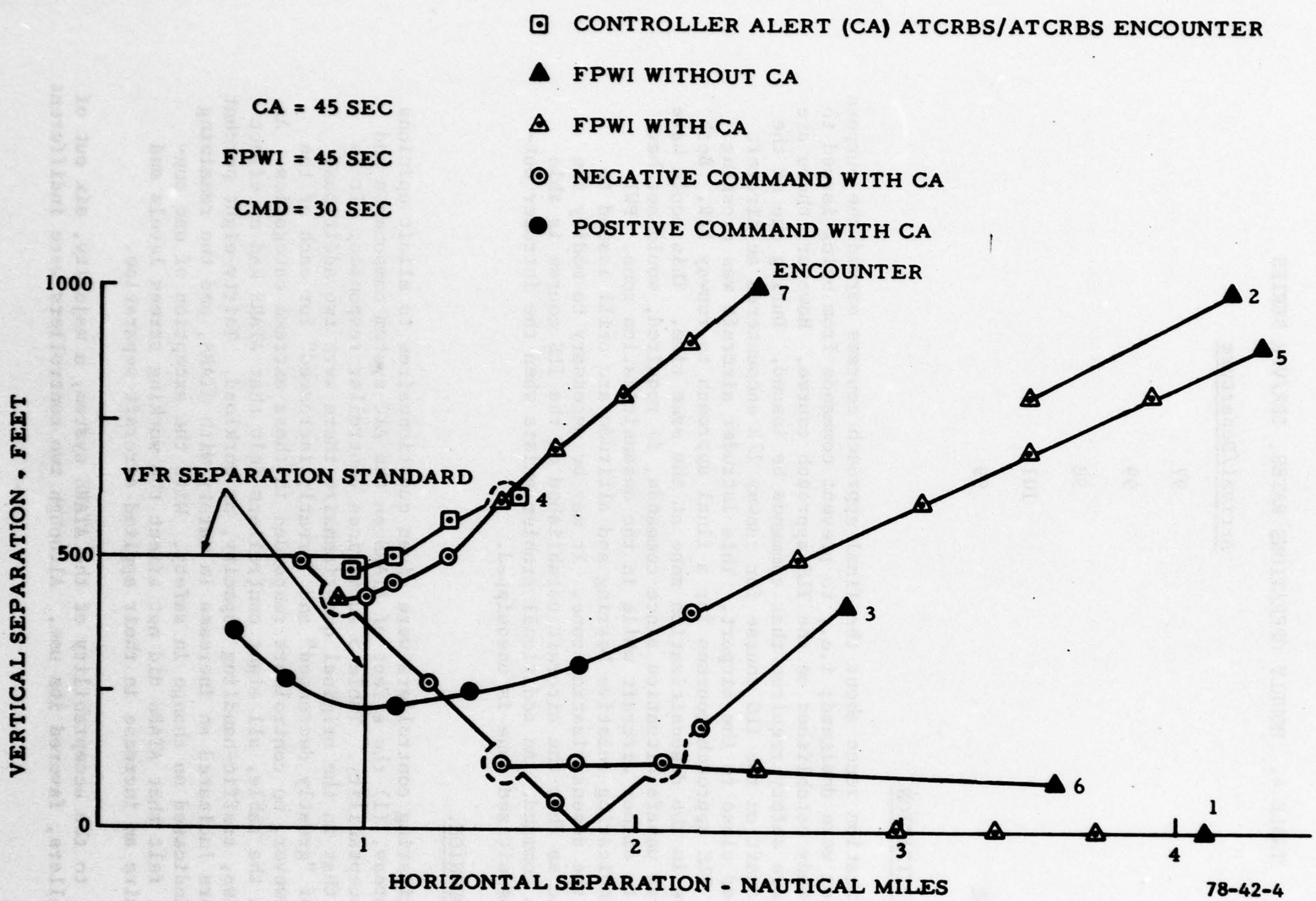

FIGURE 4. AIRCRAFT SEPARATION, ARRIVAL/DEPARTURE IFR/VFR SERIES

TABLE 4. HOURLY OPERATIONS RATES, IFR/VFR SERIES

Run	Arrival/Departure
1	97
2	99
3	98
4	101
AVERAGE	99

ATARS DESENSITIZATION.

The desensitization zones about the final approach courses served the purpose for which they were designed; i.e., to prevent commands from being issued to aircraft already established on the ILS approach course. However, there are instances where safety requires that commands be issued. During one of the runs, an aircraft on the ILS course for runway 27R encountered an aircraft being vectored close to the airport. This intruder aircraft was crossing the parallel ILS approach courses for a final approach to runway 32R. Both aircraft were in the desensitization zone at the same time. This could have resulted in an unsafe situation since commands, if required, would not have been issued to either aircraft while in the desensitization zone. PWI advisories indicating relative bearing and altitude are still issued to aircraft in the desensitization zone. It may be necessary to modify the current logic so that the aircraft established on the ILS course is able to receive a command. An additional problem exists when the intruder outside the desensitized zone is unequipped.

CONTROLLER OPINION.

Eight participating controllers were given questionnaires to elicit opinions in two key areas, (1) the effect of ATARS on the ATC system components and (2) ATARS acceptability. Table 5 summarizes controller responses. It is to be noted that in the original questionnaire there were two additional categories of "greatly decreased" and "greatly increased" for each of the factors. However, no controllers responded in these extreme categories. As indicated in the table, all eight controllers felt that ATARS had no effect on orderliness, traffic-handling capacity, or workload. Thirty-eight percent of controllers indicated an increase in safety with ATARS, and the remaining 62 percent indicated no change in safety. With the exception of one controller, all felt that ATARS did not affect the working stress levels and did not require an increase in their applied aircraft separation.

With respect to the acceptability of the ATARS system, a majority, six out of eight controllers, favored its use. Although two controllers were indifferent

TABLE 5. SUMMARY OF CONTROLLER OPINION

		Decrease (%)	No Change (%)	Increase (%)
I.	**ATARS Affect On:**			
A.	Orderliness	0	100	0
B.	Traffic-Handling Capacity	0	100	0
C.	Safety	0	62	38
D.	Workload	0	100	0
E.	Stress	0	88	12
F.	Applied Separation	0	88	12
II.	**ATARS Acceptability:**			
A.	Strongly Oppose	0		
B.	Oppose	0		
C.	Indifferent	25		
D.	Favor its use	75		
E.	Strongly favor	0		

to its use, no controllers were opposed. This is in direct contrast with the controller opinions expressed in previous IPC tests (reference 1) where the majority of controllers opposed ATARS use. Controller opposition was based on the ATARS high alarm rates experienced in the previous tests. These alarm rates averaged 7 per hour in the arrival/departure IFR series to 12 per hour in the high-density all-arrival IFR series, and 10 per hour in the arrival/departure IFR/VFR series; whereas, only 7 alarms were generated in all of the current tests.

CONCLUSIONS

Based on the results of the simulation tests, it is concluded that:

1. Unnecessary ATARS alarms have been significantly reduced by the introduction of site-adaptation logic.

2. ATARS with the site-adaptation logic did not interact adversely with controllers, and controller opinion favored its use in the terminal environment tested.

3. ATARS did provide adequate separation between conflicting aircraft pairs.

4. The algorithm does not adequately handle the special circumstances of controlled VFR traffic in which minimum separation criteria of 1 nmi or 500 feet are employed. Controller alerts and commands still occur when aircraft are separated by more than these minima.

5. The desensitization zone about the final approach courses did not provide protection against crossing intruder aircraft and unequipped intruders.

6. When ATARS alarms occurred in the tests, they were located at vector and altitude crossover points for arrival/departure pairs and in the final approach area for converging opposite-side arrival pairs. There is a need to evaluate ATARS in a terminal environment which contains more crossover and converging flightpaths than the relatively few that existed in these tests to see if such areas would present any serious problems.

7. ATARS did provide adequate protection in vertical conflicts; however, nuisance alarms were generated for aircraft following ATC clearance to level off 500 feet away from another aircraft. The ATARS vertical tracker's inability to quickly sense a level-off caused such alarms. This problem would be alleviated to a great degree if aircraft were to reduce vertical speed when 1,000 feet from assigned altitude. Similarly, tracker problems exist with the ATARS horizontal tracker which lags the actual heading of aircraft during turns.

RECOMMENDATIONS

1. <u>ATARS desensitization</u>. Develop and test a final approach desensitization zone which protects against crossing aircraft, unequipped intruder aircraft, and aircraft inadvertently straying off the ILS course. This could be accomplished by modifying the logic and by reshaping and reducing the size of the desensitization zone used in these tests. The logic should include an aircraft heading check to ensure that aircraft not aligned with or within a small angular deviation of the runway heading would be issued commands if required. Logic should be introduced to provide commands to ILS aircraft to protect against unequipped intruders. In addition, the desensitization zone should be reconfigured to extend 200 feet above and 200 feet below the ILS course. This would be adequate for aircraft established on the ILS course and also provide protection against aircraft in proximity to the ILS course.

2. <u>Controlled VFR</u>. Further refine the ATARS logic to accommodate the reduced separation standards used under controlled VFR flight procedures.

3. <u>Tracker Performance</u>. Investigate the possibility of reducing tracker lag by improving turn and climb/descent/level-off detection.

4. <u>Additional terminal ATC tests</u>. Assess ATARS performance in a terminal area with more crossover and converging flight patterns. In addition, determine the impact of uncontrolled aircraft flying in proximity to controlled aircraft in a terminal environment.

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APPENDIX

ATARS ENCOUNTER PLOTS

This appendix contains two plots for each of the seven ATARS encounters that occurred over four 1-hour data runs. The first plot shows the flightpath position in the horizontal (x, y) plane relative to a coordinate system centered at the airport. The right ILS course is located at 0.40 nmi, and the left ILS course is at -0.40 nmi on the vertical axis. Direction of flight of an aircraft proceeds from the point where the aircraft indentification is listed on the plot. The "+" symbol is the radar position of the aircraft, and the short vector is the ATARS 4-second tracker-projected position and heading. The tabulated data on each plot are the values of the ATARS variables computed for each scan.

The second plot shows the altitude of each aircraft as a function of time. Additional ATARS variables applicable to the vertical dimension are tabulated to the right of this plot. A brief description of each encounter is given below along with comments concerning ATARS performance.

Encounter No. 1

Two DABS-equipped aircraft, NW604 and PA318, being vectored for ILS approach to 27R received four scans of FPWI. The closest separation during the FPWI was 2.97 nmi. The controller had instructed NW604 to fly heading 090° about 4 seconds prior to the first scan of FPWI, indicating his intent to sequence NW604 behind PA318 for an ILS approach to 27R.

A curve drawn through each of the aircraft position coordinates, indicated by the symbol "+" on the plots, would represent the actual flightpath of the aircraft. The short 4-second vectors located on each coordinate are the predicted track of the aircraft computed by the ATARS tracker. A comparison of the heading of the ATARS-predicted track with the heading of a tangent to the curve would show that the tracker lags the actual heading of the aircraft during turns. For example, the tracker heading lags the heading of NW604 by up to eight scans in the turn. This lag tends to trigger ATARS alarms unnecessarily and extends the duration of alarms.

Encounter No. 2

Two DABS-equipped aircraft, AA317 and CO128, being vectored for ILS approach, momentarily received two nonconsecutive 4-second scans of FPWI. Based on controller intent and a separation of 3.46 nmi and 800 feet, there appears to be no need for an alarm in this situation. These momentary FPWI are due to the tracker-predicted heading lagging the turn of aircraft CO128.

Encounter No. 3

A DABS-equipped North arrival aircraft, AA241, level at 6,000 feet, encountered a DABS-equipped departure aircraft, AA887, which had been cleared through 6,000 feet to 15,000 feet. Both received negative right-turn commands and approached within 1.7 nmi of each other before diverging in altitude.

Encounter No. 4

An ATCRBS/mode C equipped arrival, A30924, level at 6,000 feet, encountered an ATCRBS/mode C equipped departure, N5303. The departure aircraft had been cleared to altitude 5,500 feet which would provide 500 feet vertical separation, adequate under VFR operations. It can be seen in the vertical profile plot that the ATARS tracker failed to sense the level-off of N5303, and the tracker overshoot resulted in a controller alert of four scans duration. Subsequent versions of these plots are being modified to automatically indicate on the plots when a controller alert was issued.

Encounter No. 5

A DABS-equipped arrival, AA241, being vectored for approach to 27R, was cleared to descend to 6,000 feet. An ATCRBS/mode C equipped departure was level at the wrong altitude of 7,000 feet. The arrival controller expected the departure to be level at 5,000 feet. Clearly the coordinator controller should have made him aware of the situation. ATARS issued a climb command to the arrival aircraft and satisfactorily resolved an unsafe situation.

Encounter No. 6

TW97, a DABS/mode C equipped North arrival, crossed through the parallel ILS course to the south side, then turned to a heading of 300°, and was cleared for an ILS approach to runway 27R. The clearance was not taken, and the pilot again proceeded through the ILS courses, circling to the right.

The controller then put TW97 on a heading of 90° and subsequently sequenced it behind A30454. The ATARS issued two scans of FPWI and three scans of negative right. The closest point of approach between the aircraft was 1.37 nmi and 115 feet.

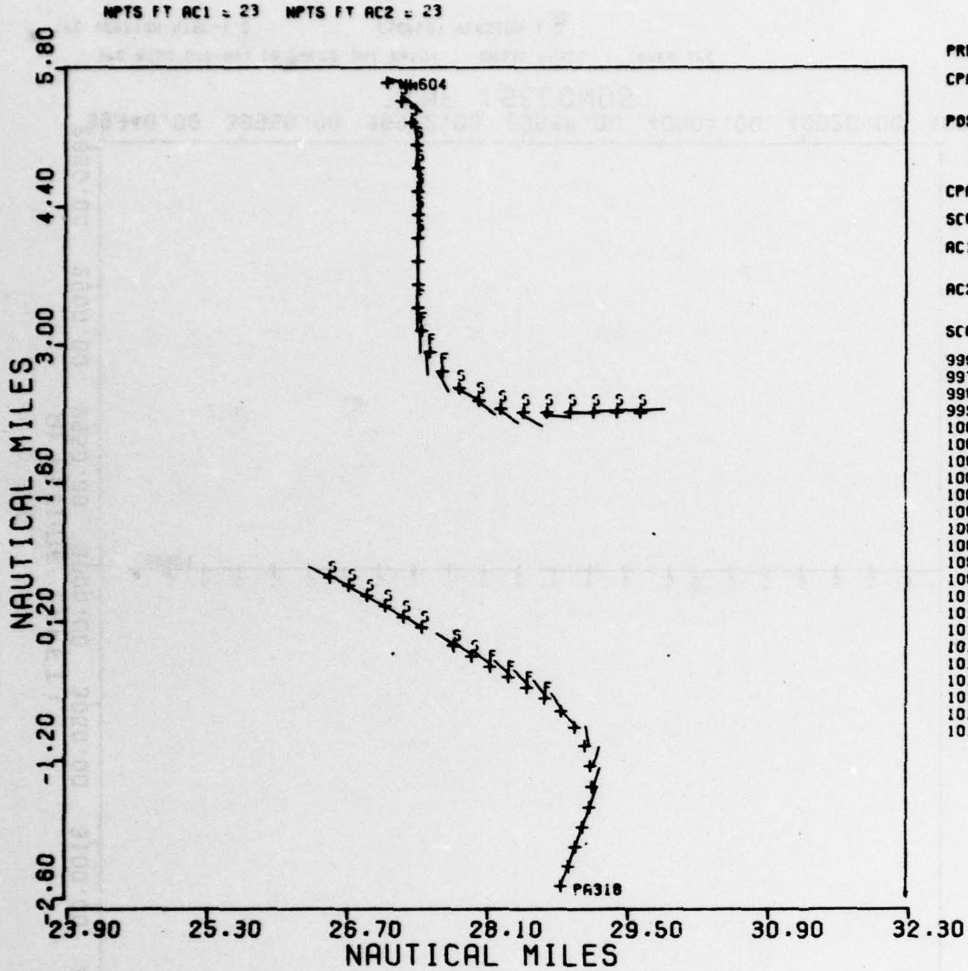
Encounter No. 7

A DABS-equipped arrival aircraft, OZ967, being vectored to an approach to 27R has been cleared to 4,000 feet altitude. This altitude is 500 feet above an ATCRBS/mode C equipped arrival, N5164W, which is being vectored for an approach to runway 32R. The vertical plot clearly shows that the ATARS tracker failed to sense the level-off of OZ967 and, as a result, triggered a negative turn command for three scans. The controller was aware of the situation, since he had four scans of controller alert starting at scan 508 prior to the command. His intent, however, was to level off OZ967 at 500 feet above N5164W, and he saw no need to alter its course.

START TIME = 11 5 44   END TIME = 11 7 12   ST SCAN = 995   END SCAN = 1019

NPTS FT AC1 = 23   NPTS FT AC2 = 23

ENCOUNTER NUMBER 1



IPC MISS DOG-AVI 18 JAN 78 INT NW604   DRONE PA318   TAPES IPC

IPC VERSION NTAC-1.0   CSCPLOT VERSION 1.2

PRES =

CPAH = 14222.359 CPAV = 0.000

POSCMD= 0   AT SCAN 0   MD= 0.0

ALT= 0.0   XANG= 0.00

CPA ON SCAN 1013 SCPA = 14222.355

SCPAH = 14222.359 SCPAV = 0.003

AC1 ID = NW604   CON DABS

AC2 ID = PA318   CON DABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
996				115	9.26	99.00	4	-0
997				87	7.88	99.00	-0	0
998				74	7.46	99.00	-3	0
999				71	7.04	99.00	-5	0
1000				64	6.63	99.00	-7	0
1001				60	6.21	99.00	-9	0
1002				56	5.79	99.00	-14	0
1003				49	5.36	99.00	-27	0
1004				47	4.93	99.00	132	0
1005				42	4.51	0.24	12	0
1006	F	F		39	4.10	0.06	3	0
1007	F	F		35	3.71	0.20	-0	-0
1008	F	F		32	3.33	0.52	-3	-0
1009	F	F		31	2.97	1.39	-5	-0
1010	S	S		41	2.67	2.18	-7	-0
1011	S	S		42	2.45	2.09	-9	-0
1012	S	S		52	2.39	99.00	-14	-0
1013	S	S		161	2.34	99.00	-32	-0
1014	S	S		2129	2.45	99.00	56	-0
1015	S	S		2520	2.66	99.00	9	-0
1016	S	S		3018	2.91	99.00	3	-0
1017	S	S		3535	3.19	99.00	0	0
1018	S	S		4418	3.51	99.00	-4	0

78-42-A-1

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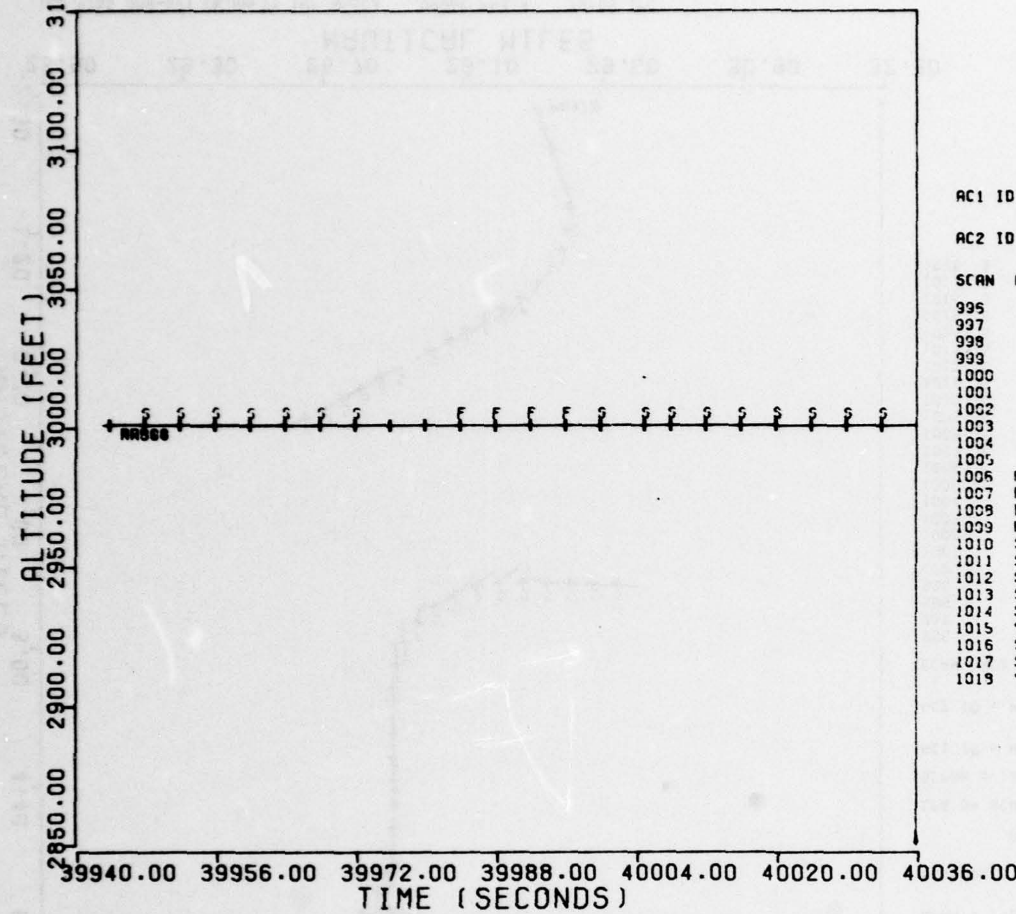
START TIME = 11 5 44 END TIME = 11 7 12 ST SCAN = 995 END SCAN = 1019 ENCOUNTER NUMBER 1

NPTS FT AC1 = 23 NPTS FT AC2 = 23



AC1 ID = NW504 CON DABS

AC2 ID = PA318 CON DABS

SCAN	AC1	AC2	RZ	VRZ	VMD	DOT	TCMD
995			-0	3.0	0.0	-2135	30
997			0	3.0	3.0	-2557	30
998			0	2.5	2.4	-2715	30
999			0	1.9	1.8	-2502	30
1000			0	1.3	1.2	-2449	30
1001			0	0.9	0.7	-2293	30
1002			0	0.4	0.3	-2137	30
1003			0	0.1	0.1	-2099	30
1004			0	-0.0	0.0	-1841	30
1005			0	-0.1	0.0	-1753	30
1006	F	F	0	-0.1	0.0	-1592	30
1007	F	F	-0	-0.1	0.1	-1408	30
1008	F	F	-0	-0.1	0.1	-1233	30
1009	F	F	-0	-0.1	0.1	-1027	30
1010	S	S	-0	-0.1	0.1	-612	30
1011	S	S	-0	0.0	0.0	-510	30
1012	S	S	-0	0.0	0.0	-390	30
1013	S	S	-0	0.0	0.0	-121	99999
1014	S	S	-0	-0.0	0.0	301	99999
1015	S	S	-0	-0.0	0.0	525	99999
1016	S	S	-0	-0.0	0.0	728	99999
1017	S	S	0	-0.0	0.0	912	99999
1019	S	S	0	-0.0	0.0	1091	99999

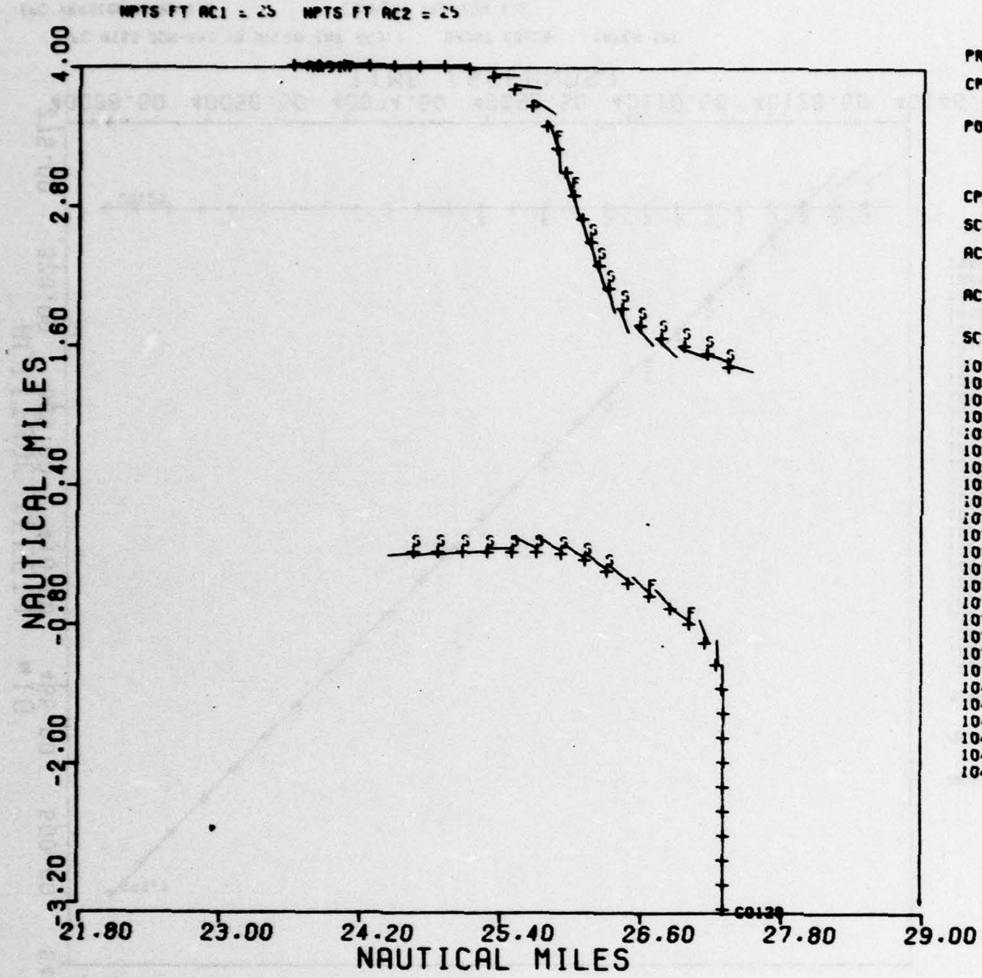
IPC MISS DD6-AV1 18 JAN 78 INT NW504 DRONE PA318 TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

78-42-A-2

START TIME = 11 7 24 END TIME = 11 9 1 ST SCAN = 1021 END SCAN = 1045 ENCOUNTER NUMBER 2.

NPTS FT AC1 = 25 NPTS FT AC2 = 25



IPC MISS DOG-AV1 18 JAN 78 INT AA317 DRONE C0128 TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

PRES =

CPAH = 13052.054 CPAV = 0.001

POSCMD= 0 AT SCAN 0 MD= 0.0

ALT= 0.0 XANG= 0.00

CPA ON SCAN 1040 SCPA = 13055.500

SCPAH = 13052.054 SCPAV = 300.041

AC1 ID = AA317 CON CABS

AC2 ID = C0128 CON CABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
1021				117	8.09	99.00	86	-2211
1022				113	7.81	99.00	81	-2104
1023				109	7.52	99.00	77	-2000
1024				105	7.24	99.00	73	-1898
1025				101	6.96	99.00	70	-1797
1026				97	6.68	99.00	67	-1697
1027				93	6.41	99.00	63	-1597
1028				99	6.12	99.00	60	-1498
1029				83	5.90	99.00	56	-1398
1030				75	5.46	99.00	52	-1299
1031				56	5.07	99.00	48	-1200
1032				45	4.64	0.18	44	-1100
1033	F	F		45	4.22	99.00	40	-1000
1034				39	3.93	0.99	36	-900
1035	F	F		35	3.46	1.13	32	-800
1036				33	3.12	1.28	28	-700
1037	S	S		31	2.79	1.41	24	-600
1038	S	S		31	2.50	1.53	20	-500
1039	S	S		33	2.27	1.67	16	-400
1040	S	S		43	2.15	1.87	12	-300
1041	S	S		1639	2.15	99.00	8	-200
1042	S	S		1891	2.31	99.00	4	-100
1043	S	S		2294	2.54	99.00	-0	0
1044	S	S		2866	2.83	99.00	-3	54
1045	S	S		3478	3.12	99.00	-5	75

78-42-A-3

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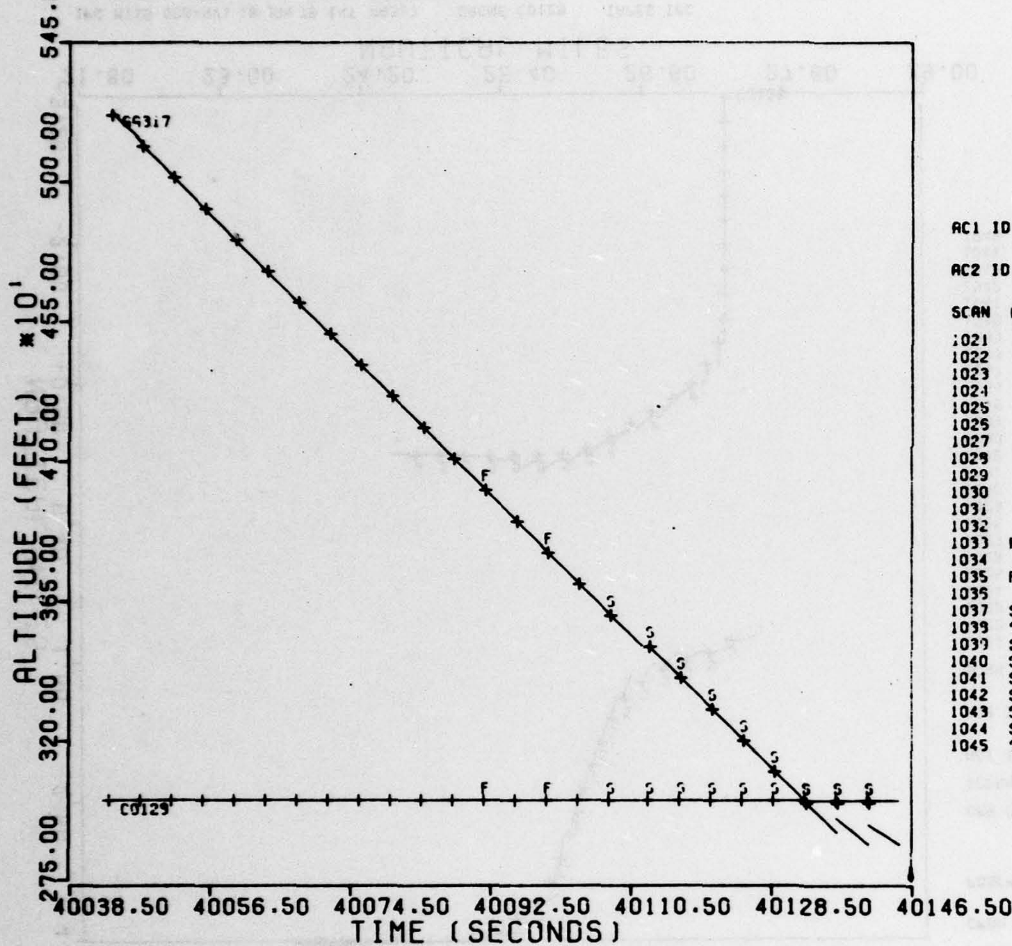


IPC MISS DD8-AV1 19 JAN 78 INT A6317 DRONE C0129 TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

AC1 ID = A6317 CON DABS

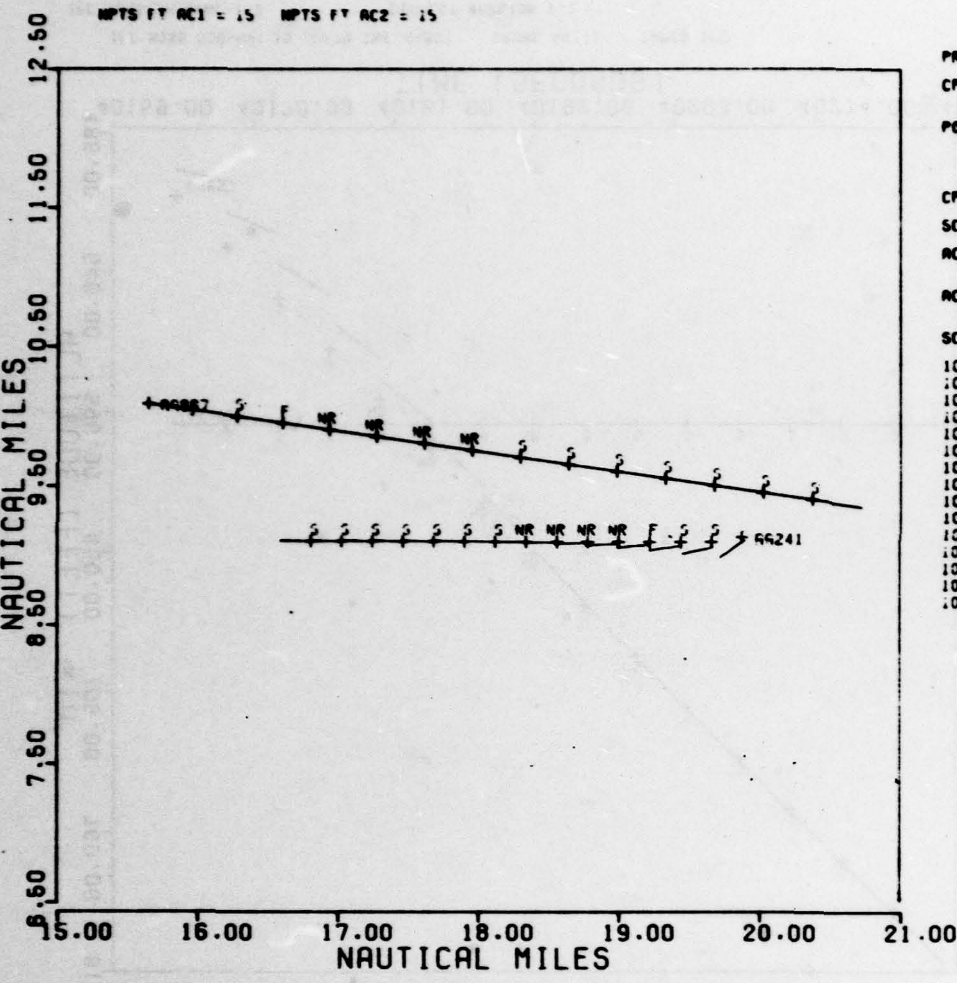
AC2 ID = C0129 CON DABS

SCAN	AC1	AC2	RZ	VRZ	VMD	DOT	TCMD
1021			-2211	1550.3	1435.1	-2006	30
1022			-2104	1567.5	1320.5	-1939	30
1023			-2000	1566.9	1216.4	-1870	30
1024			-1899	1557.0	1119.0	-1901	30
1025			-1797	1543.5	1024.9	-1729	30
1026			-1697	1530.0	931.7	-1655	30
1027			-1597	1518.4	837.9	-1579	30
1028			-1498	1509.6	743.0	-1510	30
1029			-1398	1509.4	646.8	-1459	30
1030			-1299	1499.7	549.2	-1424	30
1031			-1200	1497.7	450.7	-1644	30
1032			-1100	1497.0	351.3	-1739	30
1033	F	F	-1000	1497.0	251.5	-1415	30
1034			-900	1497.5	151.4	-1399	30
1035	F	F	-900	1499.1	51.1	-1237	30
1036			-700	1499.7	0.0	-1067	30
1037	S	S	-600	1499.2	0.0	-995	30
1038	S	S	-500	-1499.5	999.5	-725	30
1039	S	S	-400	-1499.9	1099.8	-555	30
1040	S	S	-300	-1500.0	1200.0	-377	30
1041	S	S	-200	-1500.1	1300.1	60	99999
1042	S	S	-100	-1500.1	1400.1	253	99999
1043	S	S	0	-1500.1	0.0	539	99999
1044	S	S	54	-1294.1	0.0	789	99999
1045	S	S	75	-983.4	0.0	946	99999

78-42-A-4

START TIME = 11 9 24   END TIME = 11 10 20   ST SCAN = 1051 END SCAN = 1065   ENCOUNTER NUMBER 3

NPTS FT AC1 = 15   NPTS FT AC2 = 15



IPC MISS DDG-AV1 18 JAN 78 INT A6897   DRONE A6241   TAPES IPC

IPC VERSION NTAC-1.0   CSCPLOT VERSION 1.2

PRES =

CPAM = 3759.255 CPAV = 41.143

POSCMD= 0   AT SCAN 0   MD= 0.0

ALT= 0.0   XANG= 0.00

CPA ON SCAN 1053 SCPA = 3921.762

SCPAM = 3759.255 SCPAV = 693.919

AC1 ID = A6897   CON DABS

AC2 ID = A6241   CON DABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
1051				39	4.35	99.00	92	1008
1052				31	3.95	1.01	39	839
1053	S	S	-2	26	3.31	0.96	21	635
1054	F	F	0	21	2.77	0.76	11	414
1055	NR	NR	0	17	2.23	0.69	4	186
1056	NR	NR	0	13	1.70	0.64	-1	-41
1057	NR	NR	0	9	1.19	0.62	-5	-264
1058	NR	NR		9	0.76	99.00	-9	-482
1059	S	S		101	0.62	99.00	-13	-694
1060	S	S		259	0.91	99.00	-17	-901
1061	S	S		645	1.39	99.00	-21	-1105
1062	S	S		1263	1.90	99.00	-25	-1306
1063	S	S		2114	2.44	99.00	-30	-1506
1064	S	S		3197	3.00	99.00	-34	-1705
1065	S	S		4515	3.55	99.00	-39	-1904

78-42-A-5

START TIME = 11 9 21 END TIME = 11 10 20 ST SCAN = 1051 END SCAN = 1065 ENCOUNTER NUMBER 3

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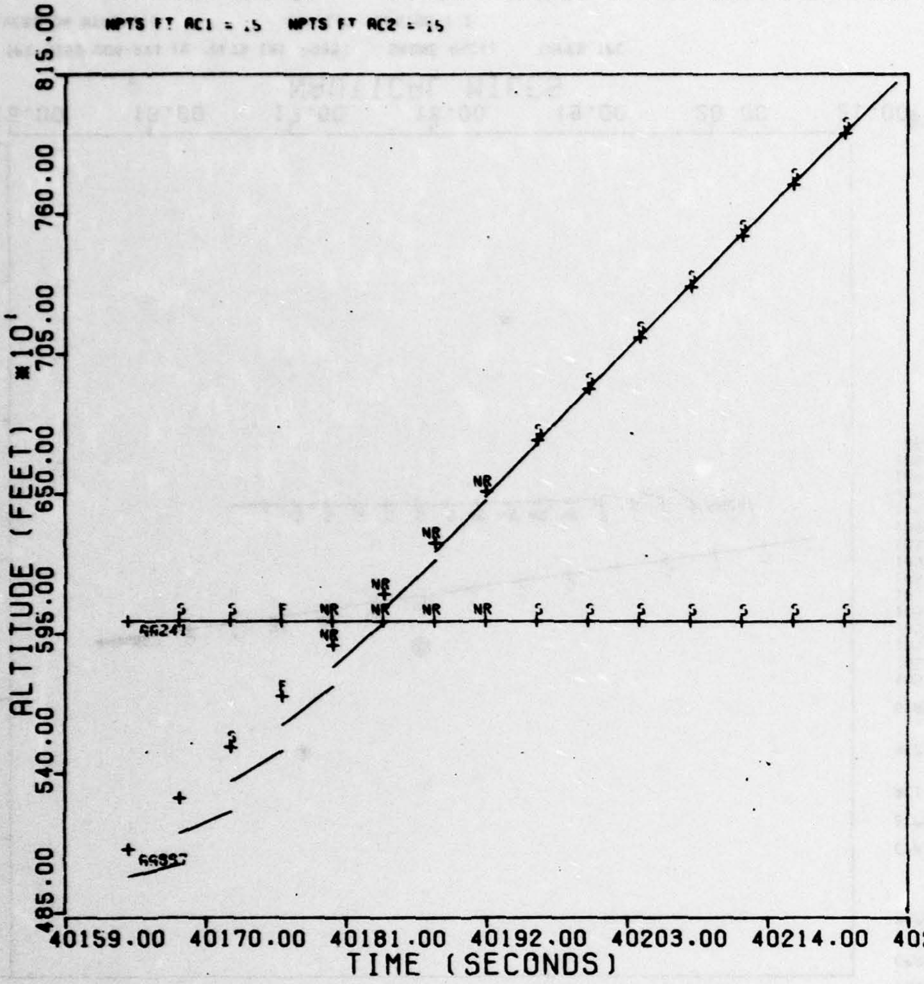


AC1 ID = AA897 CON DABS

AC2 ID = AA241 CON DABS

SCAN	AC1	AC2	RZ	VRZ	VMD	DOT	TCMD
1051			1009	-734.8	640.3	-1749	30
1052			833	-1293.5	191.9	-1724	30
1053	S	S	635	-1839.9	0.0	-1510	30
1054	F	F	414	-2298.4	0.0	-1278	30
1055	NR	NR	196	-2645.7	0.0	-1031	30
1056	NR	NR	-41	-2892.8	2841.7	-772	30
1057	NR	NR	-264	-3026.9	2762.6	-504	30
1058	NR	NR	-482	-3100.2	2618.4	-229	30
1059	S	S	-694	-3125.1	2431.2	52	99999
1060	S	S	-901	-3120.4	2219.3	337	99999
1061	S	S	-1105	-3100.6	1995.7	623	99999
1062	S	S	-1306	-3075.5	1769.2	912	99999
1063	S	S	-1506	-3051.2	1545.1	1202	99999
1064	S	S	-1705	-3030.8	1325.7	1494	99999
1065	S	S	-1904	-3015.4	1111.6	1796	99999

IPC MISS 006-AV1 18 JAN 78 INT AA897 DRONE AA241 TAPES IPC

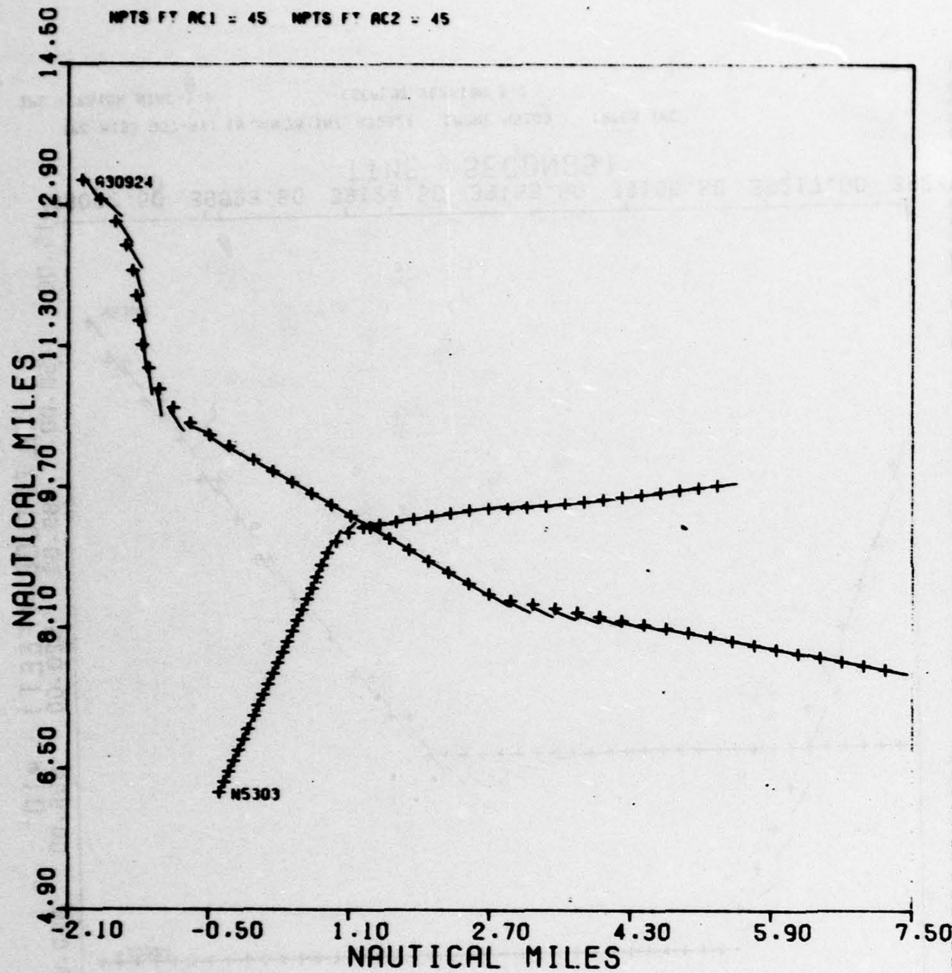
IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

78-42-A-6

START TIME = 10 51 7 END TIME = 10 54 4 ST SCAN = 777 END SCAN = 821

NPTS FT AC1 = 45 NPTS FT AC2 = 45

ENCOUNTER NUMBER 4



IPC MISS 007-AV1 19 JAN 78 INT A30924 DRONE N5303 TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

PRES =

CPAM = 5042.648 CPAV = 3.182

POSCMD= 0 AT SCAN 0 MD= 0.0

ALT= 0.0 XANG= 0.00

CPA ON SCAN 798 SCPA = 5063.304

SCPAM = 5042.648 SCPAV = 456.937

AC1 ID = A30924 CON ATCB

AC2 ID = N5303 CON ATCB

SCAN	AC1	AC2	POS	TM	RANGE	MD	TV	RZ
777				74	7.15	99.00	112	-1609
778				76	6.77	99.00	94	-1528
779				65	6.39	99.00	99	-1480
780				60	5.98	99.00	90	-1411
781				54	5.57	99.00	100	-1372
782				50	5.18	99.00	91	-1309
783				47	4.79	99.00	76	-1228
784				44	4.39	99.00	79	-1180
785				41	4.02	99.00	71	-1111
786				39	3.55	99.00	59	-1026
787				35	3.30	99.00	62	-977
788				42	2.97	99.00	56	-907
789				34	2.68	99.00	61	-869
790				31	2.40	99.00	55	-806
791				30	2.05	0.84	44	-726
792				28	1.81	99.00	45	-679
793				26	1.55	0.80	39	-610
794	CA			24	1.32	0.80	42	-572
795	CA			22	1.11	0.81	35	-509
796	CA			26	0.93	0.82	39	-474
797	CA			61	0.83	99.00	47	-459
798				226	0.83	99.00	66	-457
799				289	0.93	99.00	105	-462
800				402	1.09	99.00	195	-470
801				539	1.25	99.00	484	-479
802				665	1.39	99.00	5743	-487
803				779	1.49	99.00	-1196	-493
804				896	1.59	99.00	-802	-497
805				990	1.68	99.00	-779	-500
806				1093	1.76	99.00	-894	-501
807				1195	1.84	99.00	-1150	-502
808				1293	1.92	99.00	-1634	-502
809				1397	1.99	99.00	-2590	-502
810				1480	2.05	99.00	-4778	-501
811				1566	2.10	99.00	-11855	-501
812				1663	2.17	99.00	126	-454
813				1771	2.24	99.00	43	-375
814				1899	2.31	99.00	20	-275
815				2013	2.39	99.00	9	-165
816				2144	2.46	99.00	0	-3
817				2278	2.53	99.00	-5	145

78-42-A-7

START TIME = 10 51 7 END TIME = 10 54 4 ST SCAN = 777 END SCAN = 821 ENCOUNTER NUMBER 4

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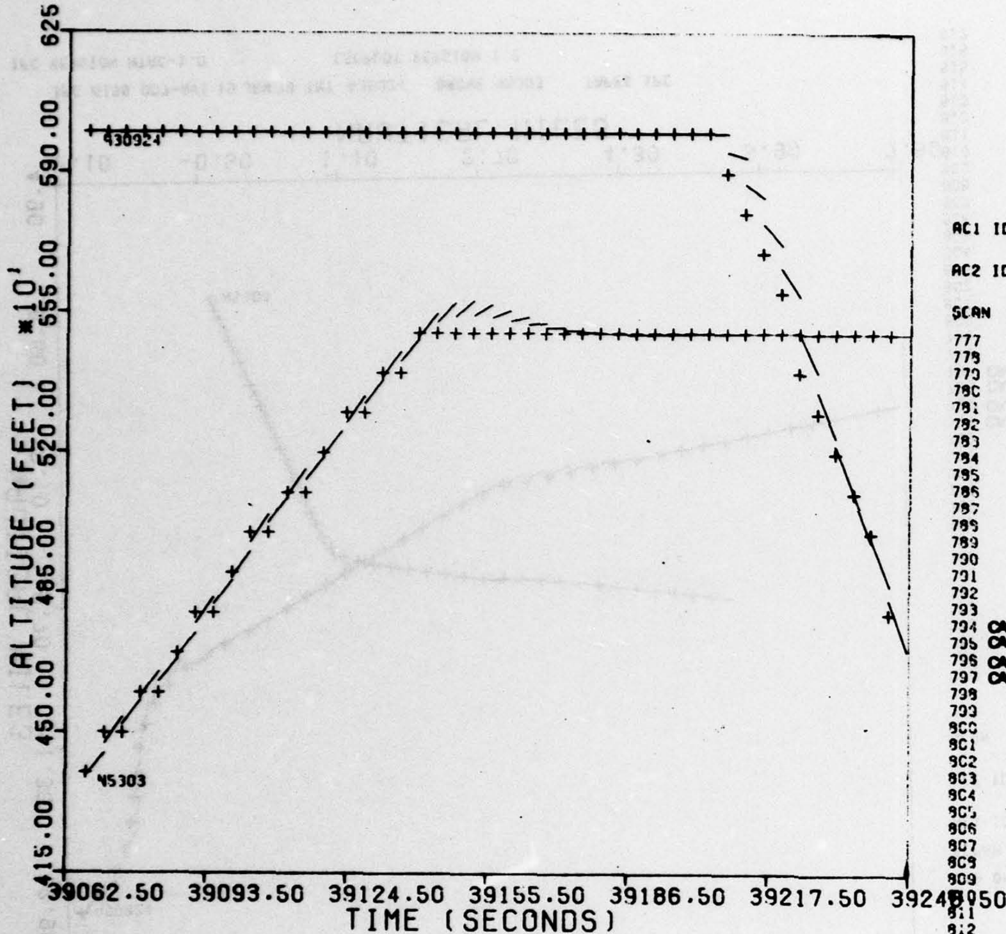


IPC MISS DD7-AV1 19 JAN 78 INT A30924 DRONE N5303 TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

AC1 ID = A30924 CON ATCB

AC2 ID = N5303 CON ATCB

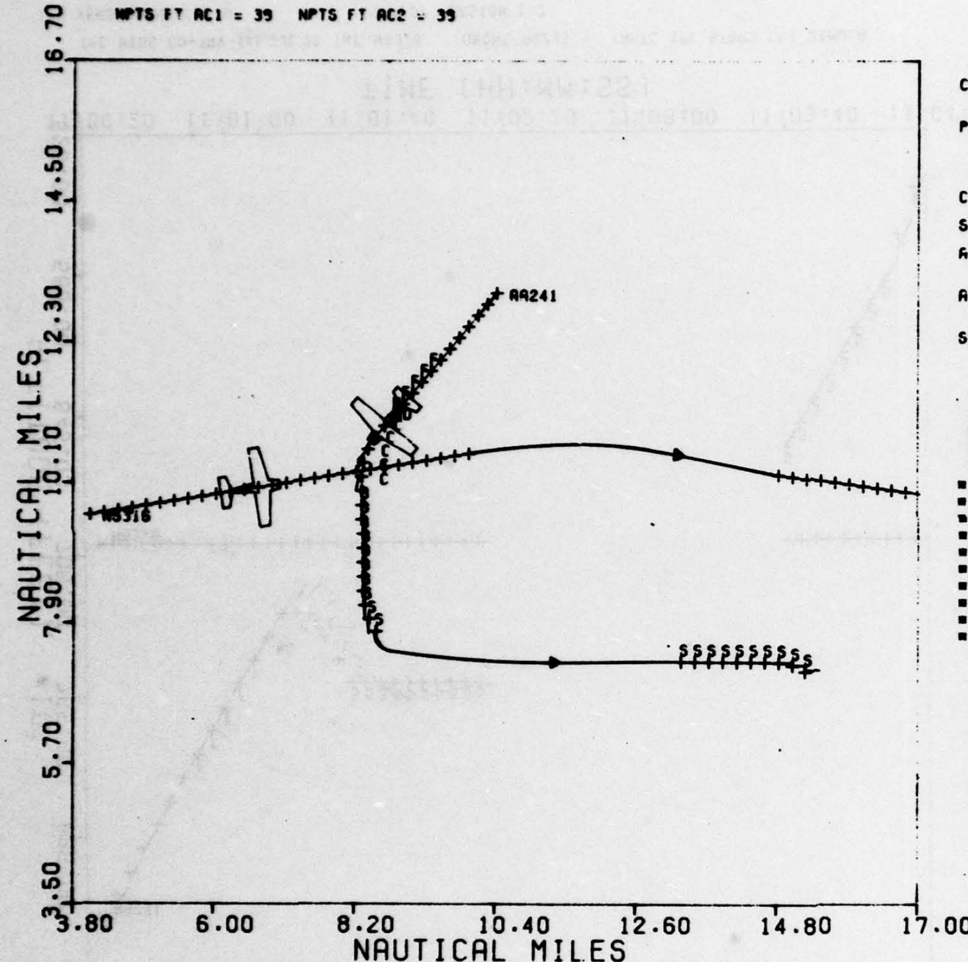
SCAN	AC1	AC2	RZ	VRZ	VMD	DOT	TCMD
777			-1609965.2		1176.6	-2471	-17
778			-1529076.5		1039.4	-2159	-17
779			-1490995.5		1032.2	-2248	-17
780			-1411939.2		941.3	-2140	-17
781			-1372827.3		959.6	-2073	-17
782			-1309864.2		877.0	-1918	-17
783			-1229975.5		739.8	-1752	-17
784			-1190894.8		732.6	-1594	-17
785			-1111939.5		641.6	-1420	-17
786			-10261042.9		504.4	-1264	-17
787			-977	948.7	502.3	-1104	-17
788			-907	977.6	418.4	-746	-17
789			-869	852.3	442.8	-762	-17
790			-806	978.4	357.3	-655	-17
791			-726	991.0	234.7	-493	-17
792			-679	896.0	230.7	-409	-17
793			-610	935.9	141.7	-332	-17
794	CA		-572	-923.0	252.0	-259	-17
795	CA		-509	-960.7	351.6	-187	-17
796	CA		-474	-755.5	282.4	-113	-17
797	CA		-459	-591.7	132.6	-37	-17
798			-457	-418.2	39.9	42	99999
799			-462	-264.9	197.0	123	99999
800			-470	-144.7	325.5	199	99999
801			-479	-59.4	419.5	220	99999
802			-487	-5.1	481.4	173	99999
803			-493	24.7	480.2	155	99999
804			-497	37.2	478.3	189	99999
805			-500	39.5	480.4	185	99999
806			-501	33.6	484.4	180	99999
807			-502	26.2	489.7	173	99999
808			-502	18.4	492.7	168	99999
809			-502	11.6	495.9	161	99999
810			-501	6.3	498.2	151	99999
811			-501	2.5	499.7	142	99999
812			-454	-215.9	239.3	139	99999
813			-375	-517.8	142.9	137	99999
814			-275	-821.1	545.9	140	99999
815			-165	-1081.4	916.8	145	99999
816			-3	-1407.2	1404.1	152	99999
817			145	-1720.5	0.0	160	99999

78-42-A-8

START TIME = 1' 0 24 END TIME = 11 4 16 ST SCAN = 916 END SCAN = 974

NPTS FT AC1 = 39 NPTS FT AC2 = 39

ENCOUNTER NUMBER 6



IPC MISS DD-7AV-111 JUL 78 INT N5316 DRONE AA241 TAPES IPC ATARS CHI SIMULA

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

CPAM = 3302.321 CPAV = 225.208

POSCMD= 1 AT SCAN 920 MD= 860.9

ALT= 398.4 XANG= 139.20

CPA ON SCAN 933 SCPA = 3321.985

SCPAM = 3302.321 SCPAV = 360.917

AC1 ID = N5316 CON ATCB

AC2 ID = AA241 CON DABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
916				70	7.25	99.00	93	1667
917				65	6.82	99.00	73	1551
918				61	6.40	99.00	61	1435
919				57	5.98	99.00	53	1322
920				52	5.55	99.00	47	1211
921				48	5.13	99.00	42	1104
922				44	4.71	0.14	38	1000
■ 923		F		40	4.29	0.14	35	897
■ 924		F		36	3.87	0.14	31	797
■ 925		F		33	3.45	0.14	27	697
■ 926		F	-2	29	3.03	0.14	24	597
■ 927		F	0	25	2.61	0.14	20	498
■ 928		ND	1	21	2.19	0.14	16	398
■ 929		C	1	17	1.78	0.14	12	299
■ 930		C	1	13	1.37	0.18	12	246
■ 931		C	1	9	1.01	0.25	14	225
■ 932		C	1	9	0.70	0.45	35	271
933		C		58	0.54	99.00	-219	361
934		S		92	0.57	99.00	-47	475
935		S		178	0.75	99.00	-42	555
936		S		345	1.01	99.00	-47	604
937		S		594	1.31	99.00	-58	629
938		S		926	1.63	99.00	-78	639
939		S		999	1.95	99.00	-114	639
940		S		999	2.28	99.00	-185	633
941		S		999	2.60	99.00	-356	625
942		S		999	2.90	99.00	999	617
943		S		999	3.16	99.00	999	610
965		S		483	3.30	99.00	-15	-400
966		S		490	3.28	99.00	-19	-502
967		S		495	3.25	99.00	-23	-603
968		S		498	3.22	99.00	-28	-703
969		S		500	3.20	99.00	-32	-803
970		S		501	3.17	99.00	-36	-902
971		S		501	3.15	99.00	-40	-1002
972		S		512	3.13	99.00	-44	-1101
973		S		635	3.14	99.00	-44	-1247
974		S		999	3.18	99.00	-42	-1426

78-42-A-9

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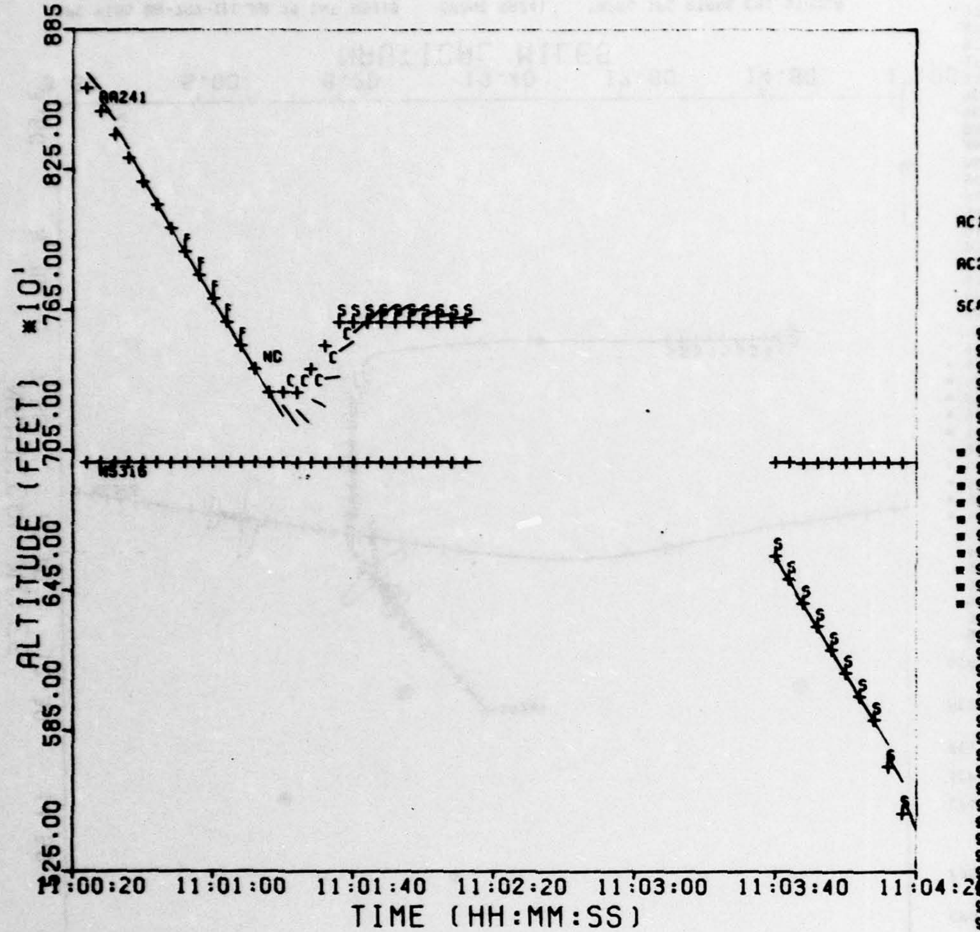
START TIME = 11 0 24 END TIME = 11 4 16 ST SCAN = 916 END SCAN = 974

NPTS FT AC1 = 39 NPTS FT AC2 = 39

ENCOUNTER NUMBER 6



IPC MISS DD-7AV-111 JUL 78 INT N5316 DRONE AA241 TAPES IPC ATARS CHI SIMULA

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

AC1 ID = N5316 CON ATCB

AC2 ID = AA241 CON DABS

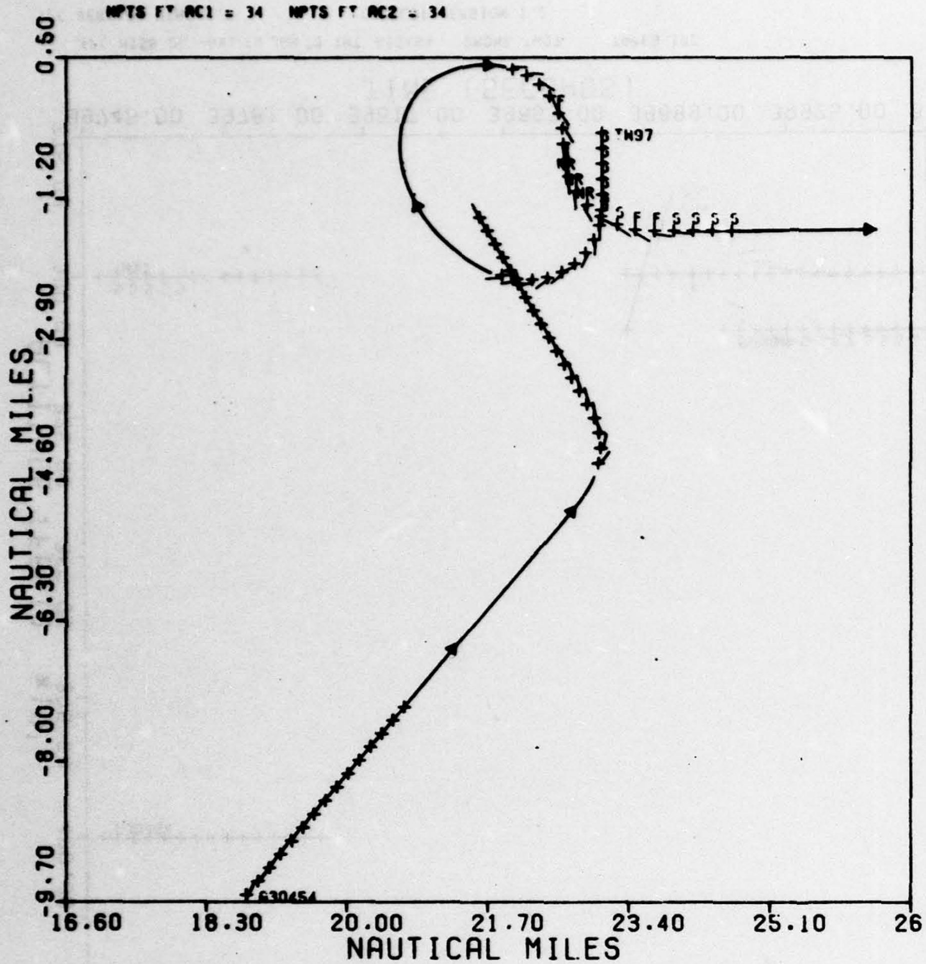
SCAN	AC1	AC2	RZ	VRZ	VMD	DDT	TCMD
916	C	C	1667	-1070.1	1131.7	-2694	30
917	C	C	1551	-1276.1	913.1	-2561	30
918	C	C	1435	-1418.8	726.0	-2419	30
919	C	C	1322	-1506.9	568.4	-2269	30
920	C	C	1211	-1553.2	434.9	-2114	30
921	C	C	1104	-1570.3	319.1	-1956	30
922	C	C	1000	-1569.4	215.1	-1795	30
■ 923	C	C	897	-1559.9	117.9	-1634	30
■ 924	C	C	797	-1544.8	24.1	-1472	30
■ 925	C	C	697	-1530.8	0.0	-1310	30
■ 926	C	C	597	-1518.9	0.0	-1149	30
■ 927	C	C	498	-1509.7	0.0	-989	30
■ 928	C	C	398	-1503.4	0.0	-829	30
■ 929	C	C	299	-1499.5	0.0	-669	30
■ 930	C	C	246	-1281.6	0.0	-513	30
■ 931	C	C	225	-980.2	0.0	-352	30
■ 932	C	C	271	-461.5	40.6	-179	30
933	C	C	351	99.0	261.9	-14	30
934	C	C	475	601.2	125.8	61	99999
935	C	C	555	783.7	229.0	159	99999
936	C	C	604	-768.7	219.4	259	99999
937	C	C	629	-650.0	304.5	359	99999
938	C	C	639	-492.7	392.7	461	99999
939	C	C	639	-337.5	469.8	564	99999
940	C	C	633	-205.7	529.9	669	99999
941	C	C	625	-105.4	572.2	768	99999
942	C	C	617	-36.5	598.9	848	99999
943	C	C	610	5.7	604.8	783	99999
965	C	C	-400	1567.0	0.0	-81	99999
966	C	C	-502	1557.1	0.0	-78	99999
967	C	C	-603	1543.6	0.0	-76	99999
968	C	C	-703	1530.0	0.0	-75	99999
969	C	C	-803	1518.5	43.6	-73	99999
970	C	C	-902	1509.6	147.4	-72	99999
971	C	C	-1002	1503.5	249.8	-71	99999
972	C	C	-1101	1499.7	351.1	-68	99999
973	C	C	-1247	1713.7	390.0	-55	99999
974	C	C	-1426	2013.7	418.7	-24	99999

78-42-A-10

START TIME = 11 2 29   END TIME = 11 5 57   ST SCAN = 947   END SCAN = 999

NPTS FT AC1 = 34   NPTS FT AC2 = 34

ENCOUNTER NUMBER 6



IPC MISS 007-AV1 19 JAN 79 INT A30454   DRONE TW97   TAPES IPC

IPC VERSION NTAC-1.0   CSCPLOT VERSION 1.2

PRES =

CPAH = 9307.679   CPAV = 0.133

POSCMD= 0   AT SCAN 0   MD= 0.0

ALT= 0.0   XRNG= 0.00

CPA ON SCAN 992   SCPA = 9308.472

SCPAH = 9307.679   SCPAV = 115.017

AC1 ID = A30454   CON ATCB

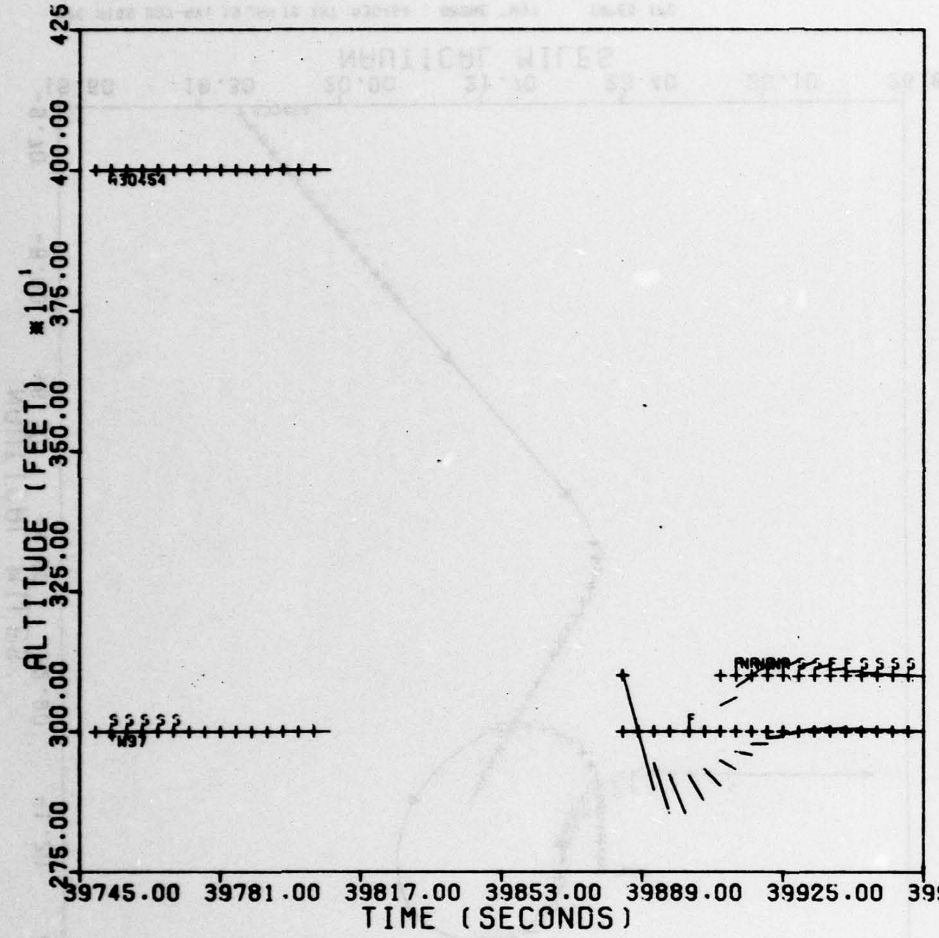
AC2 ID = TW97   CON DABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
947				114	10.18	99.00	-126307±5000	
948				109	9.80	99.00	1949675±1000	
949				103	9.42	99.00	1949675±1000	
950				98	9.04	99.00	1949675±1000	
951				93	8.67	99.00	1949675±1000	
952				89	8.29	99.00	1949675±1000	
953				84	7.91	99.00	1949675±1000	
954				79	7.52	99.00	1949675±1000	
955				73	7.13	99.00	1949675±1000	
956				76	6.75	99.00	1949675±1000	
957				69	6.39	99.00	1949675±1000	
958				67	6.05	99.00	1949675±1000	
959				77	5.75	99.00	1949675±1000	
960				81	5.51	99.00	1949675±1000	
961				87	5.32	99.00	1949675±1000	
981				119	4.91	99.00	4	-104
982				83	4.63	99.00	-0	0
983				56	4.31	99.00	-3	56
984				42	3.95	0.60	-5	78
985	F			39	3.55	1.14	-7	78
986				34	3.18	1.13	-9	67
987			-2	23	2.82	0.61	-13	98
988	F		0	26	2.46	0.59	-18	115
989		NR	0	22	2.10	0.65	-25	122
990		NR	0	20	1.78	0.78	-35	122
991		NR		23	1.51	1.14	-55	119
992	S			125	1.37	99.00	-100	115
993	S			669	1.39	99.00	-249	111
994				824	1.53	99.00	-82059	107
995				1114	1.78	99.00	439	104
996				1529	2.08	99.00	308	101
997				2032	2.39	99.00	301	100
998				2627	2.71	99.00	348	99
999				3315	3.05	99.00	451	99

78-42-A-11

START TIME = 11 2 29 END TIME = 11 5 57 ST SCAN = 947 END SCAN = 999 ENCOUNTER NUMBER 6

NPTS FT AC1 = 34 NPTS FT AC2 = 34



IPC MISS 007-AV1 19 JAN 78 INT A30454 DRONE TW97 TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

AC1 ID = A30454 CON ATCB

AC2 ID = TW97 CON DABS

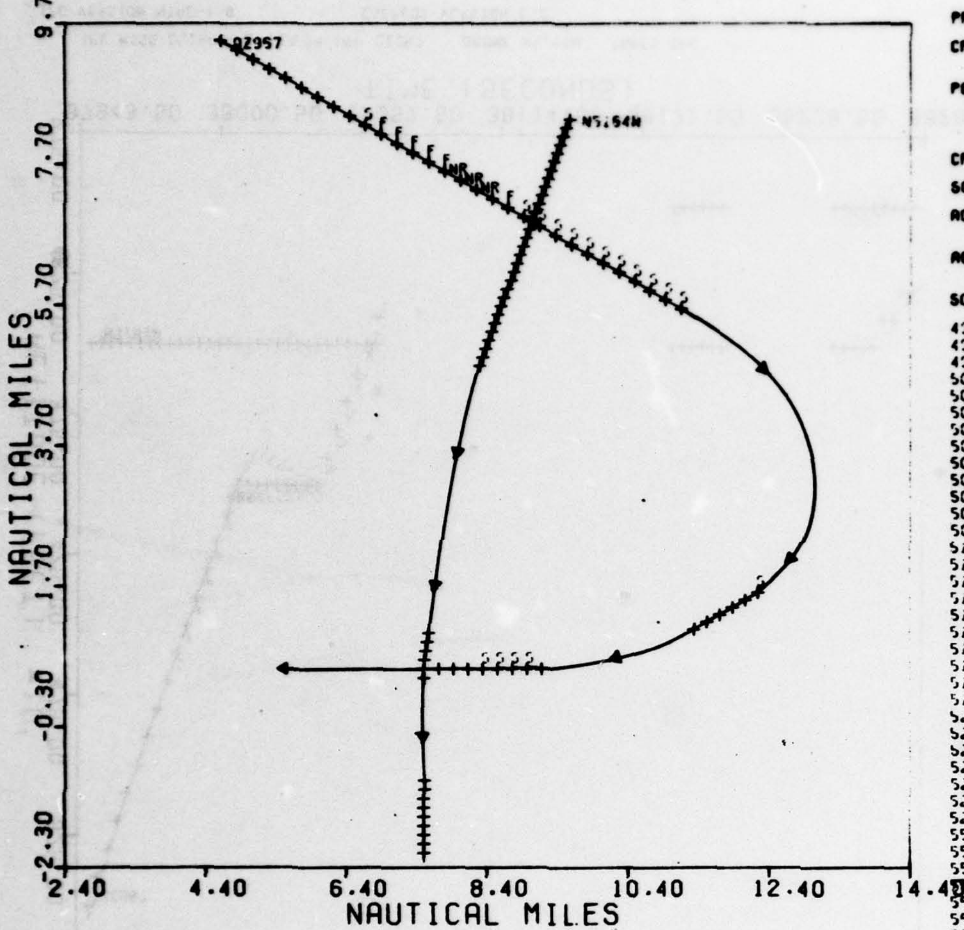
SCAN	AC1	AC2	RZ	VRZ	VMD	DOT	TCMD
947			-1000-0.0		1000.0	-3279	30
948			-10000.0		1000.0	-3165	30
949			-10000.0		1000.0	-3096	30
950			-10000.0		1000.0	-3009	30
951			-10000.0		1000.0	-2909	30
952			-10000.0		1000.0	-2797	30
953			-10000.0		1000.0	-2683	30
954			-10000.0		1000.0	-2570	30
955			-10000.0		1000.0	-2506	30
956			-10000.0		1000.0	-2155	30
957			-10000.0		1000.0	-2141	30
958			-10000.0		1000.0	-1970	30
959			-10000.0		1000.0	-1537	30
960			-10000.0		1000.0	-1354	30
961			-10000.0		1000.0	-1164	30
981			-104	-1567.5	1463.2	-729	30
982			0	-1556.9	0.0	-927	30
983			56	-1341.0	0.0	-1185	30
984			78	-1026.8	0.0	-1332	30
985		F	78	-710.5	0.0	-1169	30
986			67	-439.7	0.0	-1055	30
987			98	-445.9	0.0	-974	30
988		F	115	-395.4	0.0	-942	30
989		NR	122	-297.6	0.0	-703	30
990		NR	122	-207.6	19.5	-559	30
991		NR	119	-129.5	54.6	-352	30
992		S	115	59.0	46.0	-52	99999
993		S	111	26.6	83.9	40	99999
994			107	0.1	106.5	197	99999
995			104	-14.2	96.5	407	99999
996			101	-19.8	91.5	545	99999
997			100	-19.9	90.1	678	99999
998			99	-17.1	90.7	807	99999
999			99	-13.2	92.4	930	99999

78-42-A-12

10

START TIME = 10 32 29 END TIME = 10 39 1 ST SCAN = 497 END SCAN = 590

NPTS FT AC1 = 45 NPTS FT AC2 = 45



IPC MISS DDI9AV1 2 FEB 79 INT 0Z957 DRONE N5164W TAPES IPC

IPC VERSION NTAC-1.0 CSCPLOT VERSION 1.2

ENCOUNTER NUMBER 7

PRES =

CPRM = 5520 992 CPAV = 52.095

POSCMD= 0 AT SCAN 0 MD= 0.0

ALT= 0.0 XANG= 0.00

CPA ON SCAN 515 SCPA = 5537.219

SCPRM = 5520 992 SCPAV = 425.021

AC1 ID = 0Z957 CON DABS

AC2 ID = N5164W CON ATCB

SCAN	AC1	AC2	POS	TM	RANGE	MD	TV	RZ
497				75	5.09	99 00	96	-2050
498				71	4.91	99 00	92	-1934
499				67	4.54	99 00	73	-1921
500				63	4.27	99 00	66	-1711
501				60	4.00	99.00	61	-1604
502				56	3.74	99.00	57	-1500
503				52	3.47	99 00	54	-1398
504				49	3.21	99.00	50	-1297
505				45	2.95	99.00	47	-1197
506	S			42	2.69	0.99	43	-1097
507	F			39	2.44	0.99	40	-999
508	F			35	2.19	0.99	35	-898
509	F			32	1.95	0.99	32	-799
510	F		-2	29	1.71	0.99	29	-700
511	F		0	27	1.49	0.99	24	-600
512		NR	0	25	1.29	0.90	20	-500
513		NR	0	27	1.11	0.90	21	-447
514		NR		34	0.99	0.90	25	-425
515	F			99	0.91	99 00	39	-425
516	S			279	0.91	99 00	62	-435
517	S			334	1.00	99 00	123	-450
518	S			442	1.14	99 00	344	-465
519	S			603	1.32	99 00	-5330	-479
520	S			915	1.53	99 00	-594	-499
521	S			1079	1.75	99 00	191	-449
522	S			1393	1.99	99 00	50	-375
523	S			1759	2.22	99 00	22	-279
524	S			2176	2.47	99 00	10	-169
525	S			2544	2.72	99 00	3	-53
526	S			3162	2.97	99 00	-3	53
556	S			119	4.70	99 00	-2049105500	
557				116	4.54	99 00	1166935500	
559				112	4.39	99 00	260097 500	
560				109	4.24	99 00	204025 500	
550				105	4.07	99 00	209501 500	
561				99	3.90	99 00	247499 500	
572				179	2.30	99 00	4519557500	
573	S			346	2.25	99 00	2073591600	
574	S			1762	2.22	99 00	1345597500	
575	S			1764	2.23	99 00	9959321500	
576	S			1910	2.26	99 00	7305095500	

78-42-A-13

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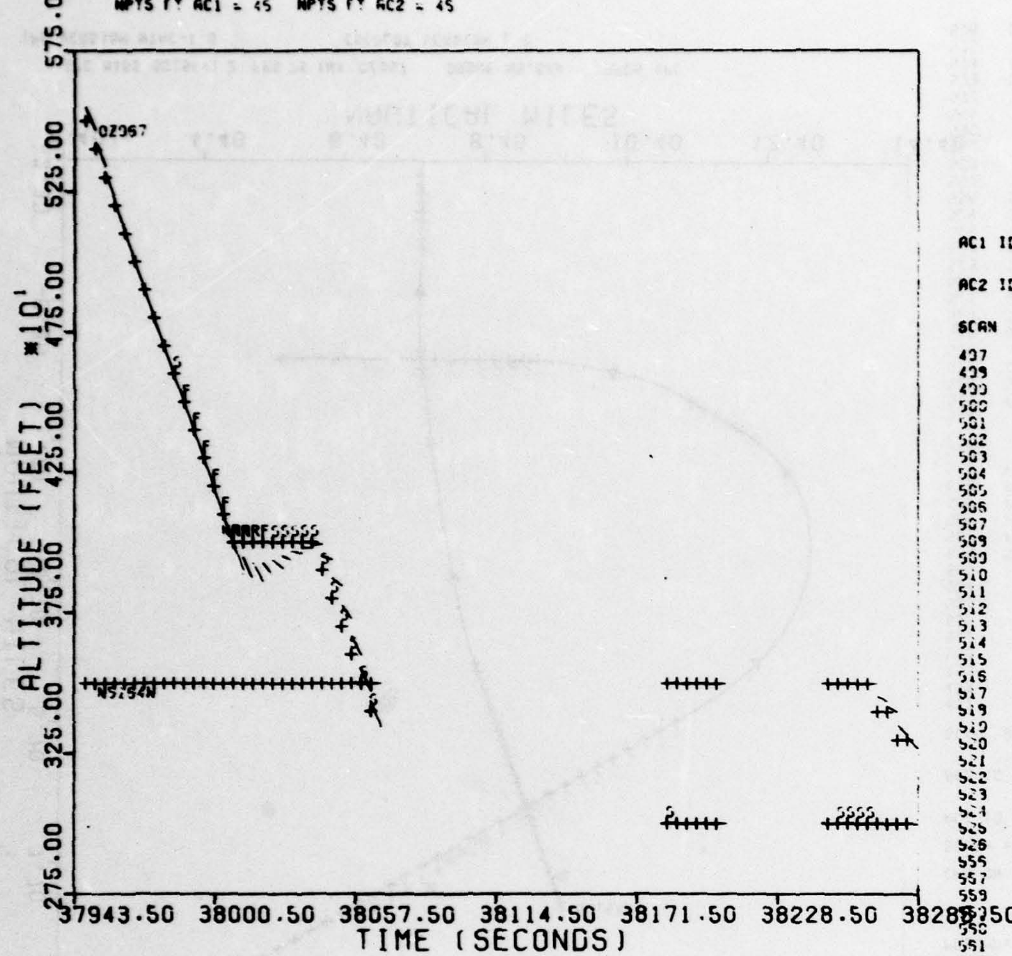
START TIME = 10 32 29   END TIME = 10 39 1   ST SCAN = 497   END SCAN = 550   ENCOUNTER NUMBER 7

NPTS FT AC1 = 45   NPTS FT AC2 = 45



IPC MISS DD1SAV1 2 FEB 79 INT 02957   DRONE N5154W   TAPES IPC

IPC VERSION NTAC-1.0   CSCPLOT VERSION 1.2

AC1 ID = 02957   CON DABS

AC2 ID = N5154W   CON ATCB

SCAN	AC1	AC2	RZ	VRZ	VMD	DOT	TCMD
497			-2050	1279.7	1409.9	-1241	30
498			-1934	1419.7	1225.1	-1172	30
499			-1921	1504.9	1059.0	-1103	30
500			-1711	1550.3	936.1	-1034	30
501			-1604	1557.5	820.5	-964	30
502			-1500	1566.9	716.4	-896	30
503			-1309	1557.0	619.0	-827	30
504			-1207	1543.5	524.9	-759	30
505			-1197	1530.0	431.7	-691	30
506	S		-1007	1518.4	337.9	-623	30
507	F		-909	1509.6	243.0	-555	30
508	F		-909	1503.4	146.9	-489	30
509	F		-799	1499.7	49.2	-423	30
510	F		-700	1497.7	0.0	-356	30
511	F		-600	1497.0	0.0	-290	30
512		NR	-600	1497.0	0.0	-224	30
513		NR	-447	1291.5	0.0	-159	30
514		NR	-425	991.4	0.0	-93	30
515	F		-425	579.2	85.4	-28	30
516	S		-436	-419.5	16.1	37	99999
517	S		-450	-219.8	230.6	102	99999
518	S		-466	-91.2	394.4	168	99999
519	S		-479	4.9	476.2	233	99999
520	S		-493	50.3	453.5	298	99999
521	S		-449	-148.6	300.7	363	99999
522	S		-375	-449.9	75.1	427	99999
523	S		-279	-762.5	494.9	491	99999
524	S		-169	-1035.3	959.4	555	99999
525	S		-53	-1249.9	1105.8	619	99999
526	S		63	-1400.3	0.0	692	99999
555	S		500	-0.1	500.0	-668	30
557			500	0.0	500.0	-641	30
559			500	0.1	499.9	-615	30
5[illegible]			500	0.1	499.9	-593	30
550			500	0.1	499.9	-569	30
551			500	0.1	499.9	-552	30
572			500	0.0	500.0	-105	99999
573	S		500	0.0	500.0	-52	99999
574	S		500	0.0	500.0	-10	99999
575	S		500	0.0	500.0	50	99999
576	S		500	0.0	500.0	100	99999

78-42-A-14

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